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AN EPIDEMIOLOGIC STUDY OF BACK PAIN
IN AN INDUSTRIAL POPULATION

by

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B.A., Yale University, 1962

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John W. Wickenden
March, 1966

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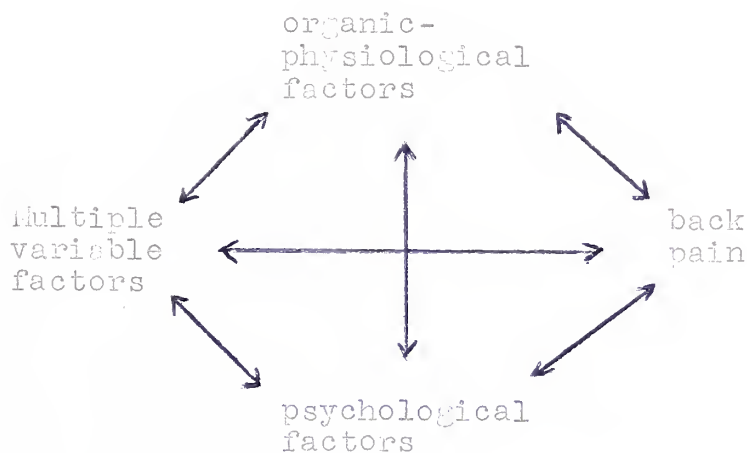
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AN EPIDEMIOLOGIC STUDY OF BACK PAIN IN AN INDUSTRIAL POPULATION

INTRODUCTION

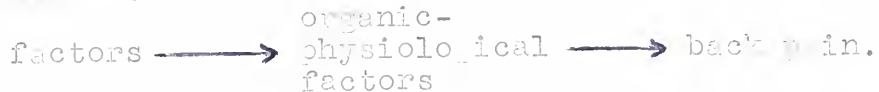
This study was undertaken with the knowledge that back pain has a multi-factor etiology. Review of the back pain literature made it quickly evident that many of the factors extant were only poorly understood. Moreover, various students of the problem rarely viewed back pain from a holistic perspective. Most physicians involved in the study and treatment of back pain were oriented so as to emphasize some relatively small cluster of factors. As a reference scheme with which to organize the data under study, the following diagram was devised.



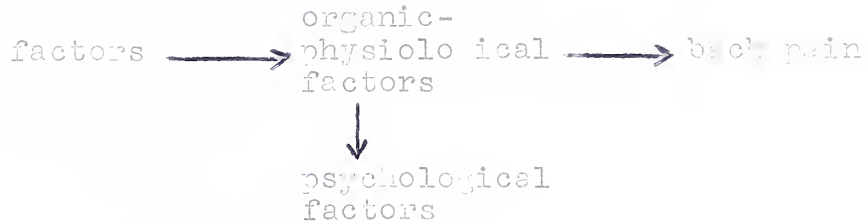
Each element in the scheme was considered to be variably a stimulus or a response.

Most of the backache literature is concerned with one

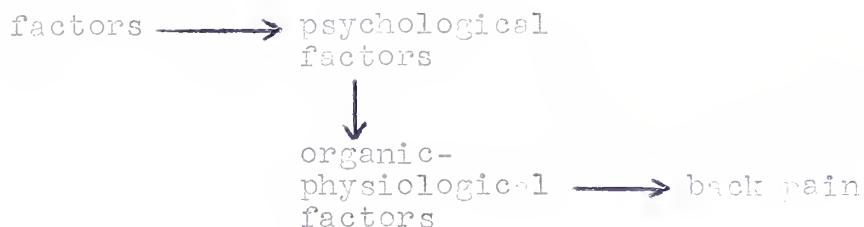
chain of events:



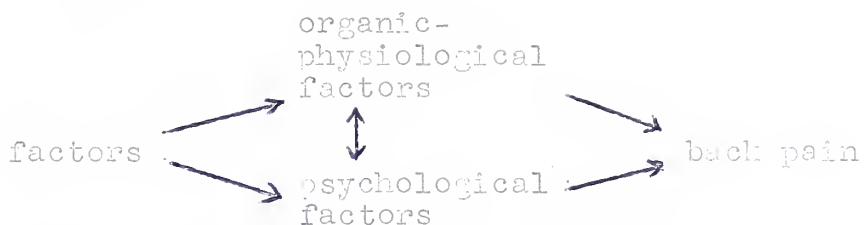
Much of the literature acknowledges, although frequently in a cursory fashion, the following chain:



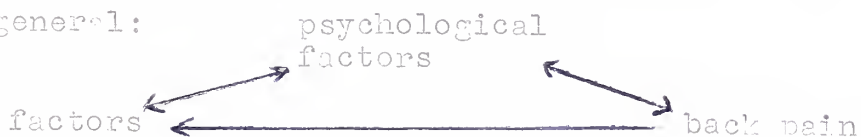
The following pattern is recognized by many back pain students, and emphasized by a few:



Smaller quantities of the backache literature recognize and define various back pain patterns which would fit a larger scheme:



A final scheme is acknowledged only rarely in the back pain literature, and then it is usually designated "hysteria" or malingering. The scheme which is represented below would be more frequently recognizable in the general accident literature and in some of the more psychologically oriented studies of pain in general:



In the review of the historical and background material which follows, illustrations of these schemes will be evident. A number of factors often considered to be significant in the causation of organic-physiological conditions which are believed to be frequently responsible for back pain will be reviewed. Some of the psychological literature will be reviewed which, it seems to this writer, are usually considered in a manner too narrow, if at all. A number of environmental and epidemiological factors will be reviewed.

The original data which are reported in this paper have been collected from the records of all of the back complaints which were made to the Medical Department of a large industrial plant in New Haven (Olin Mathieson Chemical Corporation) during a three year period. Two hundred eighty-seven back complaints were made by 251 individuals. Only limited data were consistently available from the charts of these patients. All of the data which were usually available were considered for analysis. All of those data were studied for which reasonable positive or negative hypotheses could be made.

The group of 287 complaints includes all back pain, from the neck to the lumbo-sacral region. However, "low-back" pain predominates, being the complaint in two-thirds of the complaints studied. Most of the literature is concerned with low-back pain, and in this paper primary interest is given to this region. However, low-back and other back pain probably share many common features, as will be demonstrated. Therefore, for many purposes the location of the back pain will not be differentiated.

Finally, the data reported here will be related to some of the observations which have been made in the literature which has been reviewed. It is hoped that some of the original data reported below will contribute to a better understanding of some of the dynamic factors in the schemes presented above. Specifically, it is hoped that some of the data presented will suggest some reorientation of the emphasis given to various patterns illustrated in the above schemes.

I. Historical and Background Material

A. Back Pain, a Frequent Complaint

Backache is one of the most prevalent medical complaints (51). Perhaps only the complaint of "headache" is expressed more often by more people. In one large retrospective study in which forest and industrial workers were interviewed (47), 80 percent of the men contacted acknowledged back pain. In another study (46) of normal males in Sweden, aged 25-59, 60 percent of all workers, in both light and heavy occupations, had a history of "back trouble." Diveley (21) found that 45 percent of 1000 individuals over 40 years of age had or had had back pain.

However, just as relatively few headaches come to medical attention, probably only a similarly small proportion of backaches come to medical attention. Undoubtedly many persons simply live with their back pains and never feel the need or the desire to bring them to a physician. Others treat themselves and perhaps stay at home "sick," but fail to report backache to a physician. Nevertheless, backache is still a frequent complaint of patients examined by physicians. For many orthopedic surgeons, low-back pain constitutes 15-20 percent of office, clinic, or hospital practice (87). During and after World War II, low-back conditions ranged in incidence from 15-35 percent in out-patient departments of Air Force hospitals. On the wards it was found in 10-30 percent of patients (75). Three-fifths

of the 80 percent of the population cited above as having had back pain were categorized as having had "pronounced" trouble, causing at least periodic incapacitation for work.

One of the groups which has been most concerned about back pain has been the industrial medical community. Back injuries are among the most expensive to industry, both in terms of lost employee productive capacity, and in direct costs of treatment and compensation. Troup (95) reports that in one coal mining region in England back injuries accounted for 18.5 percent of all accidents, and the incidence of back injuries causing three or more days' absence from work was 75.8 per 1000 men at risk per year. This experience is obviously an extreme, although other industries report a very high incidence of back problems. Another industry in which the employees are at high risk for back injuries is the forestry industry, where back injuries were about 12 percent of all reported accidents in 1958-59. Mann, et. al. (66) report that "back strain" accounted for 2.3 percent of all reported injuries causing loss of at least three working days in Israel. The latter figure is probably more representative of the experience in industries with no unusual combination of physical factors believed to cause back pain.

The cost of back injuries is large in proportion to their incidence. In 1951, Wilson (103) reported 100 claims brought to the industrial commission of Ohio. The average total cost of each claim was \$3121. The average work time loss for each case

was 204 days. Sixteen percent of the compensation cases settled in New York state in 1959 were for non-skeletal back injuries, but the compensation costs of these cases amounted to 23 percent of the compensation money spent that year, indicating that back cases cost, on the average, 40 percent more per injury than other compensation injuries. Thatcher (93) reported 100 consecutive, non-selected, industrial low-back cases in 1959, 81 of which had been treated without hospitalization. The average cost per case was \$1215.

These reported cases, however, represent only a small percent of the total number of backaches occurring in industrial workers or in the general population. The published reports deal with problems of severe disability often with compensation awards as a complicating factor. In contrast, this study shows that 84 percent of persons seen with backache at the Olin Medical Department did not have absence from work known to be associated with their back pain. Similar absence data are not available from other studies which have been reviewed by this writer. However, Barton (5) states that most individuals recover in a relatively short time, and few have persistent symptoms or chronic problems. Of the cases he reports, almost half had symptoms which lasted less than one week. Hult (46) reported that of the backache patients he studied, two thirds had such mild symptoms that they were either not incapacitated at all or for not more than an aggregate period of three weeks. Wilson (102) summarizes an impression with which the present report would agree: "It is

obvious that non-osseous back injuries are relatively common in industry and therefore constitute a problem worthy of special consideration, but the problem should not be magnified. Most injuries are mild and result in only temporary, not permanent, disability. The loss of time for most working men is probably relatively short, especially when considered against the lengths of their working spans."

B. Back Pain "Diagnoses"

General

A review of the literature suggests that in many instances the diagnoses of back pain must be a function of fashion rather than of precise knowledge of the patho-anatomic (or psychological) processes which are taking place. McBride (61) states that "the majority of injuries to the back in the field of industry are those with the diagnosis uncertain and the determination of the pathology indefinite." Nevertheless, many authors define diagnostic categories with terms which imply relative certainty of the processes which are responsible. French (29) states that "in the past, and all too often even nowadays, lumbago is regarded as a disease," instead of an ache in the lumbar region. Though of a tone more sophisticated than "lumbago," many current diagnostic categories are, on examination, no more precise. As illustration, Table 1 is given, showing major diagnostic categories used by several physicians in describing groups of reported cases during the last thirty years. Although the patients

Reference number	94	90	74	22	35	33
Author (date)	Thompson (1934)	Stimson (1947)	Palumbo (1954)	Diveley (1956)	Ghormley (1958)	Sheffield (1962)
lumbo-sacral strain	26	-	eliminate diagnosis	45	-	52
postural backache	17	20	-	13	-	-
sacro-iliac strain	9	-	eliminate diagnosis	7.5	-	2.6
arthritis	5	23	many	15	32	3.4
congenital anomaly	3	11	-	-	8	2
neuropsychiatric	-	15	-	-	-	-
myositis/fibrositis	-	10	-	-	0.4	4.7
intervertebral disk syndrome	-	2	most	2.3	22	24

Table 1:

Percentages of diagnoses placed in various diagnostic categories by several authors. (modified from the data presented in the references cited.)

are not necessarily comparable, the table of diagnoses illustrates the following assumptions: 1) Lumbo-sacral strain, sacro-iliac strain, postural backache, and myositis or fibrositis tend to be more or less "wastebasket" diagnostic categories, if they are accepted as diagnoses at all. The number of patients given these diagnoses tends to be related to the number of patients to whom a more specific (presumably) diagnosis cannot be given. 2) Arthritis and congenital anomaly, which are largely x-ray diagnoses, are used to the extent that the diagnosing physician is willing to attribute clinical symptoms to primarily x-ray signs which may, or may not, be causally related to the symptoms. 3) A primarily psychological diagnosis is rarely given at all. 4) One of the several diagnoses, more or less precise, relating to an intervertebral disk syndrome, is used with great variability.

Ruptured Intervertebral Disk

In 1934 Mixter and Barr (71) published their now classic report of "Rupture of the intervertebral disc with involvement of the spinal canal." This paper and others which followed have been responsible for major reorientation of the views of physicians (and the lay public) regarding low-back pain. It is interesting to note that in Thompson's thesis (94) of 1934, there is no mention of intervertebral disk pathology. Mennell (69), in the second edition (1935) of his monograph on backache, makes only fleeting reference to the intervertebral disk as the site of pathology in back pain. During the intervening years,



particularly in the literature of the mid-1950's, major attention has been focused upon lesions of the intervertebral disk as possibly causative factors in all back pain, and particularly low-back pain (2, 29, 45, 46, 47, 74). The more parochial view expresses itself as follows: "Our concepts of the basic course of low backache should change because of overwhelming evidence to favor disc pathology and changes," (74) or "The patient with low-back pain has his trouble in the intervertebral disc until proven otherwise." (45) A more catholic viewpoint, although still emphasizing the intervertebral disk, was expressed by Aufranc, et. al. (2), in a very comprehensive review of low-back pain written in 1957: "As evidence accumulates, it appears more and more probable that changes in the lumbar intervertebral discs are responsible in one way or another for most low-back and sciatic pain. The mechanism by which pain is produced, however, is not always clear. . . . Unfortunately clinical investigations are handicapped by the difficulty in establishing an exact diagnosis even at operation and by the many variables that influence the symptomatology, not the least of which are psychogenic factors and the existing laws governing workmen's compensation."

C. The Association of Various Factors with Back Pain

1. Organic-physiological factors

There are many variables that influence the symptomatology. Various physicians have given vastly different emphasis to the

importance of different variables. The reasons for differing emphasis on different variables are not always clear. It would seem in many instances, however, that the importance of a variable has been assumed almost as "common sense," without the support of critical evidence. The confusion has undoubtedly been compounded by the folklore regarding backache and by the symbolic, as well as the functional, significance of the back. The following commonplace metaphors are illustrative of the extra-functional significance attached to the back in everyday parlance (28, 91):

"pain in the neck"	"turn my back on him"
"stabbed in the back"	"when my back is turned"
"spineless"	"my aching back"
"no back bone"	"always on my back"

As many of the following examples will show, some factors have been assumed to be of importance in relationship to back pain simply because they were frequently present in association with it. However, one must question the significance of such assumptions whenever adequate controls have not been used in developing them.

Congenital and Acquired Defects

The significance of congenital and acquired defects is controversial. There are many reports in the literature of pre-employment x-ray surveys of large groups of male applicants for work. (5, 16, 19, 20, 23, 79, 80, 87, 93). These reports typically give the prevalence of the congenital and acquired

defects; but data on their **significance** in terms of their effect on an individual's vulnerability to backache or back injury are less commonly reported. Depending upon the criteria used to define x-ray presence of a congenital or acquired lesion, the percentage of job applicants found to have these defects ranges from 25 percent (80) to 60 percent (20). The importance which is given to these lesions in the origin of backaches is reflected in the numbers of applicants for employment who have been rejected on the basis of x-ray findings. Diveley (20) reports the rejection of 2.2 percent of job applicants; Colcher (16) reports a 45 percent rejection rate. Retrospective identification of the numbers of patients with backache who have given x-ray evidence of congenital or acquired lesions is similarly variable. In a series of 3500 clinic patients seen with low-back pain and/or disability, Diveley (20) found only 14 percent of them to have negative x-ray findings. Similarly, Dickson (19) found specifically congenital abnormalities in 86 percent of over 900 patients with low-back injury which he examined. Hult's extensive studies (46) suggest that the static deformities are less significant: "The frequency of symptoms from the lumbar spine among the cases with static postural deformities . . . did not differ from the normal." He believes that lumbarization, sacralization, spina bifida, and asymmetrical fifth lumbar vertebrae cause no greater tendency to develop back pain. However, he found more back trouble among those men with spondylolisthesis. These defects may not increase the

probability that an individual will have a "back injury," but they may increase the severity and duration of symptoms once backache is acquired. Whatever the truth, it is certainly accurate to conclude that "One of the major problems in evaluating disability of the back is that of determining the causal relation of pre-existing pathology to the injury." (62).

Postural Factors

A factor closely related to the previous discussion is that of posture. There are physicians who attribute the majority of backaches to this factor (8, 49, 57). The meaning of the term "postural backache" is ill-defined, usually, including both static and dynamic postural factors. We have alluded to static factors above. Dynamic postural backache usually implies prolonged periods of spinal flexion, as in the worker who sits for lengthy periods bending forward over his work. Superficially, it would seem to be reasonable to consider this as a contributory factor to backache. However, this factor rarely describes the whole causative pattern since the postural status of a person with back pain has often been no different during the period immediately prior to the onset of back pain than during innumerable painless periods before. On a patho-anatomic basis, the designation of "postural backache" seems no more meaningful than the term "lumbo-sacral strain."

Weight and Body Type

Impressions regarding the bodily type and weight status of

backache patients are frequently expressed. For example, Wilson (104) says: "The thick-set, stocky men . . . form 85 percent of the cases seen with non-traumatic backache. Slim men of average height seldom complain of non-traumatic backache." In the only study which has carefully evaluated these factors, Hult (47) states that "subjective lumbar spine symptoms showed no relationship with bodily type."

Contemporary Way of Life

The role of our contemporary way of life, and its presumed consequences to the body's musculature, is stressed by many authors as a factor associated with the prevalence of backache. (34, 37, 44, 45, 53-55, 57). Kraus (53) expresses this as follows: "Reducing physical muscular activities to a bare minimum, our mechanized life deprives us of exercise necessary to maintain adequate fitness." This point of view may well be correct, but little evidence is documented. Two reports offer interesting cross-cultural observations to substantiate the backache-soft living association. Gardner (34) states that among the natives of Yucatan, Mexico, backache and sciatica are almost unknown. He says that brain tumor is fifty times more common than protruded intervertebral disk. He attributes this to the facts that people sleep in hammocks, walk everywhere, and often carry heavy burdens on their backs or heads. Guthrie (37) reports the incidence of backache among European supervisors and African laborers at a factory in South Africa. The incidence of backache among the former was many times greater, and the

days of work lost per episode were four times as many, in comparison with the laborers. Although the conclusions may be correct, the data are not complete enough to establish them irrefutably.

Frequently the evidence offered for the causal relationship between weak musculature and backache is that suggested by the results of treatment (see particularly 55). Aufranc, et. al. (2) state that "There can be no doubt that the development of strong trunk muscles is an essential step in the rehabilitation of patients with chronic low-back trouble regardless of other treatment."

Other reports suggest that strengthened muscles are not the only, if even the major, rewards to be derived from exercise regimes. A merging of an organic and a psychological orientation towards back pain is found in the reports of Kraus (53-55). In the treatment of backache, he generally advocates (among other modes of treatment) exercise and the avoidance of bed rest. He gives explicit recognition to the elements of psychological, and consequent physical, tension in the usual backache syndrome. He believes that physical exercise creates an important outlet for emotional stimuli, as well as offering an opportunity for improvement in muscle strength.

Backache Secondary to other Disease

Many diseases which are primary in some other anatomical location may extend to the back and produce pain, or may manifest back pain as one of their symptoms. Most of these are readily

identified as to origin, and will not become confused with the group of patients which is primarily under study in this paper. Some of these diseases may remain more obscure, and present back pain as the initial or primary symptom. Little attention will be given to these conditions in this paper, except to acknowledge their existence, and to emphasize the fact that they must be considered in the differential diagnosis of all back pain. Coincidental disease of the back may be present with any condition. Diseases of the chest (92), and genito-urinary tract (56, 65, 82), or gastro-intestinal tract and other abdominal organs (48, 57, 90, 92) may cause back pain. Hult (46) has demonstrated that low-back trouble is more common in persons with a history of stiff neck - brachialgia, presumably because of common musculo-skeletal disease processes. He (46, 47) has also gathered data which he interprets as showing no relationship between subjective lumbar spine symptoms and blood pressure, gastric disorders, hernia, allergic conditions, or varices of the extremities.

A history of intra-abdominal surgery has been associated with back pain (26, 57), sometimes in the belief that back pain was secondary to adhesions or disruption of muscular integrity, and sometimes in the belief that operation and back pain occasionally have common psychogenic etiologic causes.

2. Psychological factors

In the backache literature, there is a spectrum of interest in psychological factors. Some of the relatively comprehensive

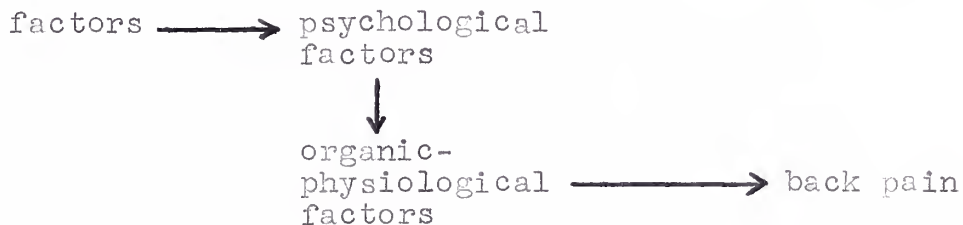
discussions of the diagnosis and treatment of the organic factors more or less completely disregard the psychological phenomena associated with backache. Typical of this category is Burke's monograph (11), in which he states: "A good deal has been written about the psychogenic aspects of backache. We believe that it is without foundation." At the other extreme there is a small body of literature concerned primarily with the psychological factors. Between these extremes are most reviews of back pain, giving at least fleeting recognition to the psychological phenomena. The following is a typical beginning to a brief last paragraph in one of these discussions of backache diagnosis: "Last, but not least, we have to consider backache as a purely psychological manifestation . . . " (69)

Frequently these writers will acknowledge a rare case of hysteria. They will express experience with the "functional" elements of back pain, but will usually assume that psychological factors are a consequence, rather than an etiological factor in the development, of the back pain. Frequently the belief is expressed, coincident with this attitude, that, as examination becomes more complete, the backaches whose symptoms seem primarily psychological will become fewer and fewer.

Many writers on backache, particularly those concerned with backache in an industrial situation, note the phenomenon frequently called "compensation neurosis." Often they are considering it as a more or less conscious phenomenon, in which the patient is knowingly magnifying his complaint with the objective of attaining a specific end, often a monetary settlement.

Frequently, however, these writers implicitly acknowledge more subtle psychological factors (as outlined below) in the development of what they call "compensation neurosis."

Better formulated and more useful concepts of the psychological factors involved in back pain have been formulated during the last fifteen years. In 1952, Hardy and Wolff (43) published their study of "Life situations, emotions, and backache." Using the scheme which has been devised above, we may illustrate the emphasis of their work in this manner:



They studied the patterns of skeletal muscle activity in 75 subjects, 65 of whom had backache. Their data suggested that "In patients exhibiting the backache syndrome the participation of bodily musculature in behavior is often characterized by (inappropriate) intense and sustained generalized hyperfunction." This muscular hyperfunction, occurring as part of the individual's reaction to a threatening life situation which stimulated conflict, anxiety, and other strong emotions, frequently provoked backache. Moreover, the etiological importance of strenuous activity or of trauma in the genesis of backache appeared to be greater when they occurred in a threatening life situation. It was postulated that sustained muscular activity caused the elaboration of a noxious tissue metabolite which accumulated in the



tissue spaces, causing pain, because of the relative ischemia of hyperfunctioning muscles.

In 1955 Sullivan (91) outlined various sets of psychological phenomena important to back pain. The factors which he noted were more thoroughly discussed in a more general study of pain published by Engel (26) in 1959. The importance of Engel's concepts is in the recognition that organic-physiological processes need not enter into the cycle. The subjective recognition of pain may be dependent upon psychological phenomena alone. In regard to back pain, specific organic-physiological processes may be altogether lacking in the back during a specific episode of pain. "There are certain individuals, whom we shall call 'pain prone,' among whom psychic factors play the primary role in the genesis of pain, in the absence as well as in the presence of peripheral lesions." Engel outlines the concept that pain acquires special meanings for the individual, and that it may yield relative pleasure to the individual. Some individuals actually seek pain. He outlines a number of features which may be demonstrated by the "pain prone" patient.

Many back pain patients may well fall into the "pain prone" category. Some of its features are: 1) a prominence of conscious and unconscious guilt, with pain serving as a relatively satisfactory means of atonement. 2) a background that tends to predispose to the use of pain for such purposes. 3) a history of suffering and defeat and intolerance of success, and a tendency to solicit pain, as evidenced by the large number of painful injuries, operations, and treatments. 4) a strong aggressive

drive which is not fulfilled, pain being experienced instead.

5) development of pain as a replacement for a loss at times when a relationship is threatened or lost. 6) a tendency toward a sado-masochistic type of sexual development, with some episodes of pain occurring in settings of conflict over sexual impulses.

A particularly interesting illustration offered by Engel is that of an "appendix syndrome." He notes the frequency of "cold" appendices removed at operation, and suggests that a history of "appendicitis" and appendectomy may sometimes offer a valuable clue for the interpretation of later pain. Although note has been given above to the occasional role of intra-abdominal disease and abdominal operations in the origin of back pain, no other suggestions have been discovered in the literature for the psychological interpretation, in relation to back pain, of such factors.

Brown, et. al. (9) have developed a set of observations which they believe to be useful in defining the degree to which psychological factors are important in patients with low-back pain. They studied 36 patients at the Massachusetts General Hospital, 23 of whom were industrial accident cases receiving compensation. Although their observations were made upon a selected population which differed from ours, they are pertinent to this discussion. They regarded psychiatric factors as significant in the disability of 24 of the 36 patients, even though 22 of the 36 had obvious demonstrable structural causes for back pain. There were no differences between the group which was receiving compensation and that which was not. They evaluated

patients for the presence or absence of the following characteristics: 1) History of present illness that was vague because of confused chronology and the introduction of material that seemed to have nothing to do with the injury and its symptoms. 2) Expression of either open or veiled resentment toward and criticism of the doctor and ancillary personnel because of alleged mismanagement and neglect. 3) Dramatic descriptions of the symptoms and of the patient's reaction to them. 4) Difficulty in localization and description of pain and other symptoms. 5) Failure of the usual forms of treatment to give significant relief from pain. 6) Accompanying neurotic symptoms. These included, most commonly, acute and chronic anxiety, insomnia, irritability, pressure-like headaches, depression with crying spells, and chronic fatigue. Brown, et. al. reported that the presence of four or more of these characteristics suggested that psychologic factors were important; two or fewer suggested that they were not.

It is probably true that back pain symptoms are seldom purely functional or purely structural in origin. Both factors must be carefully considered. However, recognition of a psychological role in the pattern of back pain will importantly influence our handling of the problem. There are implications not only for diagnosis and treatment, but also for defining the population at risk and devising ways to deal prophylactically with the problem.

3. Occupational factors

General

Reference has been made in an earlier portion of this paper to the importance of back pain to industry. The problem is frequently compounded by the added difficulty of determining whether a given complaint is "occupational," whether a major factor in the origin of the complaint is inherent in the job. Even with the full benefit of a complete history and physical examination, the question will frequently be unanswered. In addition to the subtle, unconscious psychological factors which may be acting, an employee often has a vested interest in demonstrating that his condition is occupationally related. In some instances there are higher benefit rates for industrial injuries than for sickness. An employee often believes that his job security is threatened less by an occupational back problem than by a non-occupational problem. Mock (72) states that "the medicolegal and compensation factors are responsible for a high percentage of these alleged low-back traumas." The actions of these factors make it more difficult to accurately evaluate the back pain problem.

Lifting and other Heavy Work

In spite of these difficulties, reports of back pain from industrial physicians typically report half, or more, of the back pain which is seen to be of apparent "occupational" causation. (5, 104) Heavy work, and specifically lifting, are the most frequently reported "causes" of back pain. For example, Barton

(5) reports that 35 percent of 576 consecutive cases of back pain in an industrial population were attributed to lifting. Sixty-four percent of the 286 "occupational" backaches were associated with lifting. Thirty percent of the backaches evaluated by the physicians of the Bell System (101) were attributed to lifting. Wilson (104) found that 57 percent of the backaches which he studied at an iron works in England were alleged to have arisen immediately after physical effort.

It has seemed reasonable to many observers to assume that lifting could be a causal factor in inflicting organic or physiological damage to the structures of the low back (4, 5, 62, 95). It has been calculated that lifting 100 pounds in a forward flexion position could place a 1500 pound load on the disk spaces of the lumbo-sacral region (2). Nevertheless, the back is well organized for its work. Schneider (83) asks the reasonable question: "Were the alleged conditions under which it is claimed that an injury occurred actually of such a nature as to cause damage to the lower back, or were they in no way different from innumerable similar conditions that would normally be encountered in the claimant's daily work routine?"

Undoubtedly heavy work and lifting are sometimes associated with whatever organic-physiological (or psychological) factors are implicated in backache. Troup (95) has presented rather convincing experimental evidence to confirm the clinical impression that "falls, jerks, and twists" while lifting and carrying are potentially dangerous. But, to give emphasis to the probability that these factors are not of primary importance in the etiology

of back pain, we may cite the reports of Friberg (30) and Hult (46). Friberg reported the distribution of men according to light or heavy occupations among 3672 backache patients studied. The proportions of men in each category were roughly equal to the proportions of manual laborers and others in the community at large. Hult interviewed over 1000 "normal" males, in both light and heavy occupations, to determine the incidence of low-back symptoms. He found a slight, but significant difference in the frequency with which the two groups had symptoms: 53 percent of the men engaged in light work, and 64 percent of the men engaged in heavy work, had or had had low-back symptoms. Both Friberg and Hult concluded that heavy work was implicated, but was not of an order to have decisive significance in the origin of low-back symptoms.

A more likely hypothesis would seem to be that, once given back pain, work disability is greater for those engaged in heavy work. A number of authors have suggested that this is so. (81, 95, 107).

Experience on the Job

It is sometimes stated that back pain is more frequently observed in employees relatively inexperienced in the job which they are performing. Unfortunately, few reports differentiate the factor of job experience from that of age. In a study which offers so few control data that no certain conclusions can be made, Wilkins, et. al (101) observe that approximately one half of the industrial back injuries incurred in the Bell System

occurred within an employee's first two years on a specific job assignment. They suggest that this observation implies the importance of an employee's unfamiliarity with the physical requirements of his job. Rombold and Marsh (79), having x-rayed a large number of employees in pre-placement examinations, were surprised to find twice as many backaches reported by the group of recent employees, who were x-rayed, as by the group of older employees who were not x-rayed. They made the somewhat questionable assumption that "this greater incidence in the x-rayed and therefore newly employed group of workers indicates that they had not yet learned the techniques of back protection which they had been taught. The lower incidence in the older and therefore more physically susceptible group indicates the efficacy of the constantly reiterated instructional program to which they had been longer exposed." Barr made the more reasonable, but similarly unsupported, statement that many back injuries occur in people, unaccustomed to heavy labor, who recently have started heavy jobs. Others imply a similar belief (44, 86).

Time Loss and Costs of Occupational Backache

In connection with the costs of back pain to industry (p.6), some note was made of the loss of productive capacity secondary to back problems. Some general data are available. However, virtually no good specific data are found regarding the overall occupational absence caused by back problems. Wilson (102) notes a 1955 National Safety Council release which reports that in one year's experience in Pennsylvania there were "6900 or more

back injuries . . . and a time loss amounting to over 6800 days." No more information regarding these data is available. However, if they accurately reflect the overall back experience of some representative occupational population, although further detail is not given, this supports the impressions gained elsewhere in the literature that many, perhaps most, backaches seen by industrial medical personnel do not result in any days of work absence. A relatively small number of backaches result in a relatively few days of absence. An even smaller number result in many absent days. Wilson and Wilson (104) report that the majority of employees with back pain examined at the iron works in which they practice are advised to remain at work. They report relatively few men losing one or more days of work after their first treatment, but more specific data are not given.

The data of Mann, et. al. (67) report only back "strains" which resulted in at least three days of absence from work; but of these cases, less than one quarter resulted in the loss of more than 14 working days. Hult (47) presents some cumulative data which indicate that, over a life-time, 38 percent of the normal heavy laborers, aged 35-49, examined had been incapacitated for work by lumbar spine trouble for some period of time, but for three weeks or less. Another 17 percent of the population examined had been incapacitated for a total of more than three weeks.

4. Other epidemiologic factors

Sex and Race

There are very few data in the literature regarding the sex incidence of backache. Howorth (44) states that backache equally affects both sexes, but offers no data to support his statement. Most of the studies in the literature have been concerned with the complaint in primarily male populations. No substantive consensus from the literature can be reported.

Similarly, the incidence of back problems in comparable racial groups cannot be reported. No data have been noted in the literature with which to compare the data which will be presented below.

Age Incidence

There is a considerable quantity of age incidence data available. There is general agreement that backache is primarily a problem among those in the age range from the late twenties to the late forties. Hult (46) interviewed men in various occupations to determine the numbers who had experienced back pain. He found that the age range during which the largest number of men first experienced back symptoms was 25-29 years. He concluded that the factors which cause back symptoms often make their appearance at or before the age of 30 years. However, his data do not indicate the incidence of back complaints at various ages. Data on the age incidence of "ruptured disks" are more precise (2, 4). It is generally acknowledged that most disk disease becomes clinically evident during the third and

fourth decades. Mann et. al. (67) report the numbers of reported back strains causing three or more days work loss in Israel. There were almost twice as many individuals in the group of employees under forty years of age, although the numbers of employees in the respective age groups are not defined. Boysen (8) reports that there was a distinct maximum in the 36-40 year age range in a group of 431 patients who were followed with symptoms of sciatica.

Most of the studies concerned with the age incidence of back pain attempt to relate the observed incidence to demonstrable patterns in the development of spinal pathology. Thus Hult (46) relates the age incidence to the time when the development of degenerative disk changes are beginning to be widespread. And Aufranc (2) notes that back symptoms become fewer after the age of 50 years, when substantial portions of the disk have been transformed into fibrous cicatricial tissue, and well formed spurs are present. However, Stimson (90) makes the observation that, in a large group of patients with backache, 14 out of 15 patients who were given a neuropsychiatric diagnosis were under the age of 40. This observation suggests the possibility that factors other than the evolution of organic pathology may influence the age patterns observed in patients with backache. This will be discussed at greater length below, after some factors evident in the epidemiology of all "accidents" are noted.

Time of Day

The literature was observed for reference to the time(s)

of day when back complaints were most frequently made.

Virtually no specific data were found, although Wilson and Wilson (104) reported the impression that "the first hour at work on a cold wet morning is often the time when acute attacks occur." Additionally, several discussions of so called "orthopedic backache" (13, 49) noted that pain is typically absent in the morning and becomes gradually more severe as the day progresses, suggesting that among patients examined at the onset of symptoms, there might be a larger number requesting medical attention after six to eight hours at work.

Time of Year

Data relating to the time of year when back complaints are frequent are equally imprecise. Only impressions are found in the literature. Hult (47) records the impression of the patients he examined, which was that back trouble came periodically, particularly in autumn and spring, and was associated with damp and cold. Wilson (103) reports the impression of an industry representative who believed that the incidence of back cases was heaviest in the early spring and during periods of rapid changes in outside temperature. He believed that there were few back complaints during the summer; but that the fewest complaints were made during the coldest months of the winter. Wilson and Wilson (104) stated that at an iron works in England: "Cold wet weather increases not only the pain of the chronic case, but also the actual numbers of 'traumatic' cases reporting to the department."

5. Some general factors of occupational accidents

Some of the data recorded in the more general accident literature might be of interest in relation to this study. Many accidents are believed to be significantly related to "state of mind" (25, 31, 41, 64, 84). There is probably a phenomenon which can be called "accident proneness." Persons who are "accident prone" are probably not, as was believed earlier (78), a group which is constant from year to year, demonstrating a tendency to have multiple accidents and the majority of accidents. Most persons are probably "accident prone" at one time or another, depending upon personal factors (31, 41, 84). Hirschfeld and Behan (41) illustrate the belief that a patient frequently presents a "forewarning" before a serious accident. They suggest that industrial medical officers could frequently deal very effectively with this type of warning, perhaps by watching for a sudden increased frequency of employee visits to the plant medical department.

On the basis of such concepts it would, at least, be interesting to look for possible associations between back pain and increased frequency of other "accidents." No data of this sort have been found in the back pain literature.

Similarities between the epidemiologic patterns of back pain and "accidents" may be sought. The frequency of accidents is related to age, and there is a significantly higher incidence of accidents in younger persons (66, 76, 84, 96). A similar pattern has been observed, over the age range beginning in the

mid-twenties, in patients with back pain. It is appropriate to question whether the usually alleged organic factors entirely explain the age incidence of back pain. Other similarities might be investigated in the temporal patterns of back pain and accidents. There is epidemiologic evidence to demonstrate that peak hours for industrial accidents are in the late morning and in the late afternoon, towards the ends of work periods; and there is a cyclical annual pattern of industrial accidents, with accidents steadily increasing from a low in February to a much higher rate during the summer months (64,84). Data now available for back pain are not adequate for comparison.

II. Materials and Methods

A. Location of Study

All of the data presented below have been collected from the records of employees of the Olin Mathieson Chemical Corporation (Olin or O.M.C.C.) and of the United Nuclear Corporation (U.N.C.), which share the same medical department.

O.M.C.C. is the largest single industrial corporation in the city of New Haven, Connecticut. It manufactures sporting and military firearms, ammunition, and power tools. Brass strips are rolled and thinned in a brass mill. A large research department, where work is done in metals, chemicals, and packaging, and corporate offices is situated in the New Haven plant.

There were approximately 3000 hourly paid employees at work each month during the three years from which the data for this study were taken. There were more than this number of hourly paid employees during the first year of the study, fewer during the last. The number of salaried employees was greater than 1000. All employees have access to the Olin Medical Department, which is open at all times when there are significant numbers of employees at work.

The Medical Department is run by a full-time plant physician. Under his supervision there are eight registered nurses in the regular employ of the company. All employees who report to the Medical Department are seen first by a nurse. When indicated, they are also seen by a physician. In addition to the full-time

physician, there are at least two other M.D.s who provide part-time coverage within the department. The latter are employed almost exclusively in performing routine physical examinations. Therefore, one physician sees almost all employees who are seen by a physician at the time of an unscheduled visit to the Medical Department.

B. Back Complainants Studied

The original data included in this paper were collected from the records of 287 complaints of back pain which were presented by 251 individuals to the Olin Medical Department. These 287 complaints represent all the known complaints of back pain, which were reported in the manner described below, during the three year period from January 1, 1961 until December 31, 1963. They were found by scanning all accident reports, numbering 10,661, for these three years.

"Back pain," as defined in this study, is meant to include all complaints of pain referable to the following regions, or to combinations thereof: neck, thoracic, lumbar, lumbo-sacral, or sacro-coccygeal. Also included in the meaning of back pain are those very few pains described in the medical record as occurring in the region of the scapula or trapezius muscle, or in such inadequately defined regions as simply "the back."

It is likely that other employees who had back pain were seen in the Medical Department during the period of this study, but were not included in this study. Back pain believed to be secondary to a defined disease process elsewhere (example

duodenal ulcer), was probably not included in this study. To be included in this study, the diagnostic category which was designated on the accident report must have referred directly to some area of the back.

C. Collection of Data

An "accident report is made out in the Medical Department for each initial complaint of "back pain." Additional accident reports are not made out if an employee returns to the Medical Department for further evaluation and/or treatment of a recognized back complaint for which an accident report has already been completed. Another report might be completed if, at an ill-defined later time, an employee reported that "I've got back pain again." It is evident that there is a lack of precision in this regard. However, within understandable limits it may be stated that one accident report is made out for each individual episode of back pain.

Copies of these reports were obtained from the files of the O.M.C.C. and U.N.C. Safety Offices. All of those^{which} reported a complaint of "back pain," as described above, were noted. The Medical Department files of the employees represented were then obtained. They were available for 239 of the 251 employees with back pain. From these Medical Department files, which included the original copies of all accident reports, all of the appropriate data which are noted below were taken. In those 12 instances where a Medical Department file was not found for the employee for whom an accident report had been discovered in the Safety

Office files, the accident report copy from the Safety Office was again taken, and all data which were available were recorded. Therefore, none of the employees for whom an accident report was originally found were excluded from this study. However, if for any reason the accident report for a back complaint had not been among the accident report copies in the Safety Office, then this back complaint would have been lost to this study. It is assumed that few, if any, back complaints were lost in this manner.

Some of the data which were recorded had to be obtained from Personnel Department files (i.e. absence records, and sometimes "education," or other data which were missing from the data usually available from the Medical Department records.) These files were examined for all employees represented in the study. Several of these files were not found, but in no instance was the employee excluded from the study for lack of specific data. If data were not available, this fact was recorded.

Mimeographed sheets were prepared for the collection of data. All data were recorded directly upon these sheets at the time when the data were extracted from the various records. The sheets were designed in such a manner that the original data were coded on a margin of the sheet, and the coded data were read directly from this sheet at the time when they were punched on to 80 column IBM cards. All IBM card punches were verified. Data were extracted from the IBM cards with the use of a standard sorting machine and counter, and with an IBM 407 accounting machine. Eighty column print-outs of the total data

were examined for discrepancies. In the preparation of this report, data were read directly from the print-out sheets of the accounting machine, or from the flow sheets prepared from the counts indicated by the sorting machine.

D. Data Collected

1. Factors describing the population

Sex:

Race: (white, Negro, or other).

Age: (to the nearest year on the date when the accident report was made out).

Marital Status: (married, widowed, divorced, or single).

Social Class: This factor was computed, using the two factor index of Hollingshead (42), from the employee's education and occupation. The labor grades (see below) were very conveniently amenable to division according to the value given to the occupational factor in the computation of social class by Hollingshead's method. Labor grades 1 through 3 were equivalent to those occupations given a value of five in these computations; labor grades 4 through 9 were equivalent to those occupations given a value of six; and labor grades 10 through 12 were equivalent to those occupations given a value of seven.

Time at Olin: The number of months, to the nearest month, that the individual had been employed by O.M.C.C. or U.N.C. prior to the date of the accident report for the back complaint were recorded. This time was not considered to have been broken by a

period of lay-off. However, the specific number of months was recorded only for months up to and including 24 months. Those who had been employed for longer than 24 months were so designated, with a single code.

Time in specific job: The length of time during which the employee had been employed in a specific job within the plant was recorded, using one of four designations: five days or less; six days to one month; more than one month to six months; or, more than six months.

Labor grade: This is a two-digit number, ranging from 01 to 12. It is an O.A.C.C. job classification which reflects the degree of skill required for a job, and its pay scale. The lower labor grade numbers designate the jobs of higher skill and salary.

Job description: On the basis of information provided in a rather detailed list of job descriptions, each job was classified, according to defined criteria, into one of four categories. The categories and the basic criteria which were used to define them are as follows: 1) No significant physical exertion; no lifting or working in awkward positions. 2) Manual work, but only minimal lifting or other physical exertion; five to fifteen pounds lifted frequently, or as many as 20 pounds lifted relatively infrequently. 3) Manual work with moderate lifting or other physical exertion; 15 to 40 pounds lifted frequently, or as many as 60 pounds lifted relatively infrequently; as few as 15 pounds lifted frequently if awkward movements were involved. 4) Heavy physical work; lifting or awkward movements in excess

of that noted for the previous category. The relative lack of precision in such a classification is acknowledged, but internal consistency was attained inasmuch as each job was classified and this classification was given to every employee who performed that job.

Department number: this number indicates the plant unit where the individual is employed. The exact four digit number was recorded for each employee studied.

Incentive pay: It was recorded as yes or no, whether or not the employee was being paid on an incentive basis at the time of the back complaint.

Overtime: The number of hours of overtime worked during the three days prior to the back complaint were recorded to the nearest hour, if any.

Height; Weight; and Weight status: Height was recorded in inches to the nearest inch. Weight was recorded to the nearest pound. The weight and height data were noted only when they had been recorded in the medical chart within two years of the back pain episode. Metropolitan Life Insurance Tables (70) were used to standardize weight for height. The complainants were classified as underweight, within the normal range, overweight less than 15 pounds, or overweight equal to or more than 15 pounds. Inasmuch as body frames were not known for the individuals studied, maximum desirable weights for individuals of large frame were always used in determining the weight status.

History of significant illness: Initially, the presence or absence of a number of disease categories was recorded. However,

it became evident that, in spite of reasonably complete medical records on most employees, reliability of the the specific reporting of many disease categories was exceedingly variable. Only two medical conditions were consistently recorded, a history of hernia and/or appendectomy. Therefore, only these conditions were considered in subsequent analyses.

Previous history of back pain: One of three possibilities was noted: none; not previously examined for this complaint at O.M.C.C.'s Medical Department, but reported as having been experienced in the past (either on pre-employment health questionnaires or at the time of examination for the complaint for which they were included in this study); or, examined for back pain at O.M.C.C.'s Medical Department in the past.

Disk disease: The existence of this "disease" was noted as present or absent. Each of these possibilities was further noted as documented or undocumented. It was additionally noted whether documentation was made prior to, or after, the back complaint for which the employee was included in this study. In all cases, except a small number who had undergone surgery, "documentation" implies an evaluation of the presence or absence of disk disease on the basis of x-ray examination. The interpretation of those who had made the examinations was accepted, and no attempt was made to standardize the interpretations, or the bases upon which someone had made the interpretation that disk disease was present.

Spinal Surgery: A recorded history of this surgery was noted as none, previous to the complaint for which the employee was included in this study, or subsequent to that complaint.

Absence: The exact number of whole days of medical absence during the one year before the back complaint was noted. Also, the exact number of whole days of other absence was noted. All absences which were not recorded in the personnel files as "medical" were considered to be "other." The degree of accuracy with which medical absences were recorded as such appeared to be highly questionable. Many medical absences were probably included among "other" absences because of inappropriate designation in the personnel records. Therefore, only total absence will be considered in the discussion of results which follows.

Unrelated Accidents: The numbers, if any, of accident reports for unrelated injuries during various periods of time before and after the back complaint were counted. They were counted for periods of one month, six months, twelve months, and twenty-four months both before and after the back complaint. The data were recorded in such a way that the numbers of accident reports for the longer numbers of months were inclusive of the numbers of reports for the lesser numbers of months. For a given employee, the numbers of accident reports during the various specific time periods were recorded only when the employee had been at risk for an entire time period. However, separate determinations were made of the total numbers of months (up to 24) that each employee was at risk during the 24 months both before and after the back complaint. Similarly, the numbers of accidents during these months of risk were separately recorded. The "accidents" which were counted in these determinations were all

of those for which an "accident report" had been completed at the time of visitation to the Medical Department. They include all "occupational" accidents. Typically, they are for finger lacerations or for foreign bodies embedded in soft tissues, although a wide variety of "accidents" are represented.

2. Factors describing the back pain complaint

Month: (when the back complaint was made to the Medical Department).

Day of work week: (when the back pain began; or the fact that back pain did not begin on a work day).

Hour: (the number of hours, to the nearest hour, that the employee had worked on the day when the back pain began; or the fact that the back pain did not begin on a work day).

Circumstances: One of three possibilities was noted: that the back pain began associated with lifting; associated with other trauma; or, associated with no obvious trauma. More precise definition was not possible because of the variability of the specificity with which these factors were reported.

Days before reporting: (days, if any, between the day of onset of the back pain and the day when it was first reported to the Medical Department).

Medical personnel: (by whom the patient was attended at the time of his first visit to the Medical Department for the complaint of back pain: nurse only; or, by a physician as well).

Location of back pain: One of five designations was recorded: neck; thoracic; low-back; other (including the region of the

trapezius muscle or the scapula); or, not adequately defined.

Diagnosis: One of two designations was recorded: contusion or abrasion; or, "all others appropriate to this study." The latter, in almost all instances, were "sprain" or "strain" or some analagous term.

Physical examination: These data were inconsistently and often briefly recorded. The presence or absence of the complaint of pain radiation to the buttock(s) or leg(s) was noted whenever available.

Referral: It was noted whether the employee had been referred for consultation with an orthopedic surgeon, a radiologist, or a private physician.

Follow-up visits: The number of return visits which each complainant made to the Medical Department for further evaluation and/or treatment, if any, after the initial visit.

Absence with back pain: The uninterrupted number of whole days of work lost immediately following the day on which the back pain was reported to the Medical Department was determined. It cannot be stated with certainty that all absences which were recorded as beginning on the day following examination for back pain were for reason of the back pain. Also, some absences associated with the episode of back pain may have been lost to this study because they did not begin on the day following the initial back complaint. It should be further noted that a day of work absence was counted only for those days which would probably have been work days. Therefore, if an employee presented his back complaint on Friday, and he was absent on the following Monday

but present on Tuesday, only one day of work absence was counted.

Recurrence: Examination for another episode of back pain at O.H.C.C.'s Medical Department, subsequent to the episode under study, was reported as follows: 1) none, 2) one within six months, 3) one within two years but after six months, 4) more than one within six months, or 5) more than one within two years but after six months. The criteria which were used to define a recurrence were the same as those used to include a back complaint in this 1961-63 series. Thus, most of those 36 back complaints which were second, third, or fourth complaints for one individual during the period of this study, and were included in this study, would have been counted as recurrences. Also included would have been many of the backaches which were reported to the Medical Dept. during 1964-65. Recurrence data were incomplete for recurrences which might have occurred as long as 2 years after the index backache for some of the individuals in this study. This applied to some of those for whom the date of the 1961-63 back complaint was after August, 1962, and all of those for whom the date of the back complaint was after January 1963 (two years before the time span over which data were collected). However, an individual's data were included in the general recurrence data unless he ceased being an employee prior to one of the following times: a) two years after the date of his back complaint, or b) prior to the time when his chart was reviewed, if this time was less than two years after the date of his back complaint. Therefore, recurrence data are not an accurate reflection of the actual recurrence of reported back pain during the various periods,

although they may suggest differences in the frequency of "recurrence" in various sub-groups of the whole back pain group.

3. Unknown or inappropriate data

For various reasons, various single factors or groups of factors were often unknown for, or not appropriate to, a given employee. In order to account for all back complaints studied, either the unavailability of data or its inappropriate nature to the individual employee were always noted on the data sheets or in the coding and collection of data.

E. Selection of Hypotheses

1. Characterization of the population at risk and the population with back pain

The intent of this study may, broadly, be viewed as twofold, first to investigate factors which might characterize employees who complained of back pain among the population at risk, and second to investigate the patterns of back pain within that group of employees who complained of it.

Limited data were available from the plant's records or safety offices which defined characteristics of the plant's population. It was possible to define this population, to a limited extent, according to method of remuneration (salaried or hourly paid), sex, race, and age. These data are summarized in Table 2. Age data were not directly available for any period during 1961-63. The only available count of employees by age was for hourly workers for a single date in early 1965. At that time the

Age	Employees in the Population at Risk, 1961-63						
	Salaried				Hourly Paid		
	Male		Female		Male		Female
	White	Non-white	White	Non-white	White	Non-white	White and non-white
19					33	47	4
20-24					160	239	6
25-29					119	202	21
30-34					57	82	19
35-39	Details are not available				94	97	24
40-44					186	105	50
45-49					252	63	78
50-54					289	68	81
55-59					239	53	72
60-64					184	40	47
65					23	1	0
Totals	Over 1000				1636	997	402

Table 2: Employees in the population at risk, by method of remuneration, sex, race, and age grouping. The numbers of hourly paid employees have been estimated in the manner described in the text. Data about salaried employees by sex, race, or age were unobtainable. It is known only that there were over 1000 salaried employees.

count was 2167 employees. Some correction had to be made to provide an estimated population of hourly employees by age for the 1961-63 period.

The average number of hourly paid employees during the 1961-63 period was 868 employees more than the 1965 count. With the aid of the plant's labor relations and safety personnel, an estimate was made of the manner in which the plant's population differed, by age, from the time of the back pain study to the population count in 1965. It was known that "lay-off," rather than attrition for other reasons, was primarily responsible for the smaller number of employees in 1965. It was further known that, given the seniority patterns of the employees, proportionately more younger employees had been "laid off." It was the estimate of the corporate personnel that 70 percent of the difference in the numbers of employees between the two time periods would represent employees between the ages of 18 and 29 years. Another 20 percent of the difference would represent employees between the ages of 30 and 54 years; and another 10 percent of the difference would represent employees between the ages of 55 and 65 years. In each of the first two of these three age groupings, there would be slightly more lay-off of employees at the younger end of the age grouping.

Using this information, the 1965 count of the hourly paid employee population was adjusted to make a reasonable approximation of the numbers of employees, by age, who had been at risk during an "average" time in 1961-63. It was impossible to determine the employee turnover during the period of the study.

Therefore, estimation of the age incidence of back complaints was made by relating the age distribution of the back pain group to the age distribution of a theoretical population at risk. Appropriate caution must be used in accepting the interpretations made from these data.

For the presentation which follows, an estimate of hourly paid employees by race was also made. The 1965 population count differentiated these employees by race. It was reported that there were approximately the same proportions of white and non-white employees among those "laid off" between the time of the back pain study and the time of the 1965 count. Accordingly, in correcting the 1965 count to approximate the count during the time of the back pain study, the employees who have been added to the 1965 count have been considered to be white or non-white in the same ratios as were present in the 1965 count.

Similar data are tabulated in Table 3 for those employees who presented back complaints during 1961-63.

Specific age and race data were available only for hourly paid male employees in the population at risk. For white males, the method of adjustment of 1965 data back to 1961-63 was reasonably reliable. The reliability of the estimated ages of hourly paid non-whites was less certain. The information shown by Table 2 to be available was the controlling factor in determining the kinds of hypotheses that could be tested.

Female population figures were available only for white and non-white combined, even amongst hourly paid employees. Therefore little reliability could be attached to analyses of back

Age	Employees with Back Complaints, 1961-63							
	Salaried				Hourly Paid			
	Male		Female		Male		Female	
	White	Non-White	White	Non-White	White	Non-White	White	Non-White
19					3			
20-24	1		1		32	11		
25-29	2				25	3		
30-34	4				22	4	1	
35-39					23	5		
40-44	3	1			25	11		
45-49	1		1		23	3	1	3
50-54	1		1		9	2	1	
55-59					9	3	2	
60-64					8	1		1
65					4			
Totals	12	1	3	0	183	43	5	4

Table 3: Employees in the back pain group (total 251), by method of remuneration, sex, race, and age grouping.

pain by sex. The only hypothesis tested was whether there was any difference between incidence of backache in men and women.

Racial population figures were available only for the hourly paid population. The hypothesis tested was whether there was any difference in the incidence of backache in hourly paid white and non-white males.

Age population figures were available only for the hourly paid population. The hypothesis tested was whether there was any difference in the incidence of backache in various age groupings of hourly paid white and non-white males.

Since reasonably accurate figures were available for white male hourly paid employees, and they accounted for over 70 percent of all back complaints, it was possible to select a matched control group whose data on a number of factors could be compared with white male hourly paid backache complainants.

The following method was used in the selection of a random control group which would be matched with the white male hourly paid back pain complainants by sex, race, the fact of hourly (as opposed to salaried) employment, age, and the fact of employment by the company at some time during the period of the back pain study.

The ages of the white male complainants with whom the controls were to be matched were listed consecutively. They were then broken down into five year age range groups. The percentage of complainants in each five year age range group was then determined. The matched controls were selected so that the number of matched controls in each five year age range group was equal to

the percentage of the comparable complainants in that five year age range group. One hundred 3 x 5 inch cards were then filled out, each card bearing the list of criteria which the matched control employee must meet, including the age range into which he must fall. These 3 x 5 inch cards were then thoroughly shuffled, as one would shuffle playing cards.

The next step in the selection of the control group was to go to the Medical Department files, where there are medical charts on all employees, both active and inactive. The charts in all files were consecutively counted. When the total number of charts was known (approximately 6000), the charts were recounted, and a colored file marker was placed on every sixtieth chart, thus dividing the files into 100 equal groups, each separated by a chart upon which was a file marker. The shuffled deck was then taken, and the criteria listed upon the first card were compared with the criteria of the employee represented by the first marked chart. The file marker was removed from the first chart. If the card and the employee of the given chart matched by all the listed criteria, that employee was included in the control group. If they did not, the next chart was studied, and so on, until a match was found. If, as sometimes happened, no match was found before the chart with the next marker was reached, the search was continued beyond that marker until a match was found. When it was found, that employee was included in the control group, and return was made to the chart which was now the first bearing a marker. The employee represented by this chart was now compared with the present top 3 x 5 card. This process was

continued until 100 control employees were chosen.

Mimeographed sheets had been prepared upon which the desired data were recorded for each control subject. These sheets, and all the collection procedures, were essentially similar for the back pain group and for the matched control group.

Inasmuch as some of the data, which were desired to be known for the control employees, were data which changed with time, the following method was used to give each control employee a "base date." For each control employee, the "base date" was determined to be that date, closest to July 1, 1962, upon which an accident report had been made for the given control employee, providing that there had been at least one accident during 1961-63. If there had been no accident report during that period, the "base date" was determined to be July 1, 1962. By determining the base date in this manner, it was also possible to control more exactly the comparison of "accident rates" between the control group and the back pain group. This is true because, in determining the accident rates for the back pain employees, accidents were counted around the date of the back pain accident report, and the accident report upon which was reported the back pain incident was not counted in determining the accident rates. Similarly, the accident report on the base date was not included in the determination of accident rates for the control group.

2. Comparisons of white male hourly paid back complainants and matched controls

The following questions were asked regarding the characterization of the hourly paid white male back pain complainants and

their matched controls: Did they differ according to marital status? social class? the length of time that they had been employed by the company? the length of time they had been employed in specific jobs at the plant? their labor grades? their job descriptions? their percentages who were paid on an incentive basis? weight status? the percentages who had a history of hernia or appendectomy? the percentages who had a previous history of back pain? the percentages who were believed to have disk disease? the percentages who had a history of spinal surgery? their mean absence during the one year prior to a base date? or their rate of unrelated occupational accidents?

3. Comparisons of white and Negro male hourly paid back complainants

Data were not collected for a control group matched with Negro complainants. However, the same data were collected for both Negro and white back pain complainants, and the male complainants in these two groups were compared for the factors listed in the previous paragraph.

4. Evaluation of factors describing the back pain episode

Table 4 indicates the numbers of employees who presented one, two, three, or four complaints during 1961-63, and characterizes them according to method of remuneration, sex, and race.

Of those 30 individuals who are represented more than once in the data, 25 are represented twice; four are represented three times; and one is represented four times. In analyses of the data, the distinction will be made between "employees" and

Employees with Back Complaints, 1961-63										
Number of Complaints	Salaried				Hourly Paid					
	Male		Female		Male			Female		
	White	Non-White	White	Non-White	White	Non-White	White	Non-White	White	Non-White
	Totals									
1	11	1	3	0	163	35	4	4		221
2	0	0	0	0	17	7	1	0		25
3	1	0	0	0	2	1	0	0		4
4	0	0	0	0	1	0	0	0		1
Total Employees	12	1	3	0	183	43	5	4		251
Total Complaints	14	1	3	0	207	52	6	4		287

Table 4: The numbers of employees who presented one, two, three, or four complaints of back pain during 1961-63, characterized by method of remuneration, sex, and race.

"complaints." In some instances it has been necessary to evaluate factors which are associated with the 251 individual employees. In other instances characteristics are studied which are associated with the 287 complaints. When the latter is being done, single individuals will be sometimes represented more than once. In these instances, the separate backaches of the single individual will be included in the data in a manner no different than had they been presented by separate individuals. In the presentation which follows, the designation "employee" or "employees" will mean that the data have been determined from the records of the 251 back complaints which were first or only complaints by individual employees during the three years of the study. The designation "complaints" or "complainants" will indicate that the data have been determined from the records of the 287 complaints, including those complaints which were second, third, or (in one instance) fourth complaints by an individual employee represented in the study.

The pattern of back pain was studied according to time factors as follows: monthly distribution; day of work week; hours worked before onset.

A number of other questions were asked which were unique to the group of back pain complainants, and for which there were no control data from a population at risk. Patterns of the following factors were studied in various sub-groups of the back pain complainant population:

Circumstances (as lifting or other trauma) associated with the back pain.

The duration of symptoms before reporting back pain.

The medical personnel who examined the complainant.

The anatomic location of the back pain.

The diagnostic category into which the pain was placed.

The presence or absence of radiation of the pain into the buttock(s) and/or leg(s).

The presence or absence of disk disease associated with the back pain.

Referral to another physician in the evaluation of back pain.

Follow-up visits to the Medical Department for the back pain.

Absence with back pain.

Recurrence of back pain.

F. Statistical Techniques

In most analyses, differences between proportions were studied. The standard error of the difference between two proportions was determined by the formula

$$\sqrt{\frac{p \times q}{n_1} + \frac{p \times q}{n_2}}$$

where p is the percentage in one category and q is the percentage in the other category, and n_1 and n_2 are the numbers in the two samples.

When the standard error of the difference between means was determined, the following formula was used

$$\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}}$$

where $\overset{\text{estimated}}{S}$ is the standard deviation of the universe sampled and

n is the number of individuals in the sample.

When characteristics of more than two groups were compared, the chi-square test was used.

An observed difference between two observations of 2.0 or more times the standard error was considered to be probably significant. A difference was called significant if the observed difference was 2.5 or more times its standard error.

III. Results

A. Factors Describing the Population with Back Pain

1. General factors

Sex:

Table 5 summarizes data from Tables 2 and 3. Four percent of the hourly paid employees in the back pain study were female. Thirteen percent of the population at risk were female.

Sex	Hourly paid employees in the population*at risk	Hourly paid employees in the back pain study
Male	2633	226
Female	402	9
Totals	3035	235

*Estimated as explained in Section E., p. 45.

Table 5: Distribution of hourly paid employees by sex among the population at risk and the back pain group.

During 1961-63 the incidence of back pain among hourly paid employees, per 100 employees at risk, was 8.6 for males and 2.2 for females. It is concluded that the incidence of back pain was approximately four times greater among hourly paid male employees.

Race:

Only Negroes and whites were represented among the employees who had back pain. Table 6 summarizes data from Tables 2 and 3. Nineteen percent of the hourly paid male employees in the back

pain study were Negro. Thirty-eight percent of the population at risk were Negro.

Race	Hourly paid male employees in the population* at risk	Hourly paid male employees in the back pain study
White	1636	183
Non-white	997	43
Totals	2633	226

* Estimated as explained in Section E., p. 45.

Table 6: Distribution of hourly paid male employees by race among the population at risk and the back pain group.

During 1961-63 the incidence of back pain among hourly paid male employees, per 100 employees at risk, was 11.2 for whites and 4.3 for non-whites. It is concluded that the incidence of back pain was approximately 2.6 times greater among white male hourly paid employees than among non-whites. Additional data are presented below with the presentation of age specific incidence data. For further information about characteristics of Negro male hourly paid employees, see Section 4 below.

Age:

Tables 2 and 3 have given the age distribution of the population at risk and the back pain group. The incidence of back pain in various age groupings has been computed for the male hourly paid employees. These are presented in Table 7. The incidence figures shown in Table 7 are illustrated graphically in Figure 1.

Differences between the incidence in two age groups may be illustrated. The numbers of employees aged less than 40 years,

Age	White male hourly paid employees	Non-white male hourly paid employees
19	9.1	0.0
20-24	20.0	4.6
25-29	21.0	1.5
30-34	38.6	4.9
35-39	24.5	5.2
40-44	13.4	10.5
45-49	9.1	4.8
50-54	3.1	2.9
55-59	3.8	5.7
60-64	4.3	2.5
65	17.4	0.0
All ages	11.2	4.3

Table 7: Incidence of back pain by age group during 1961-63, per 100 employees at risk, for white and non-white male hourly paid employees.

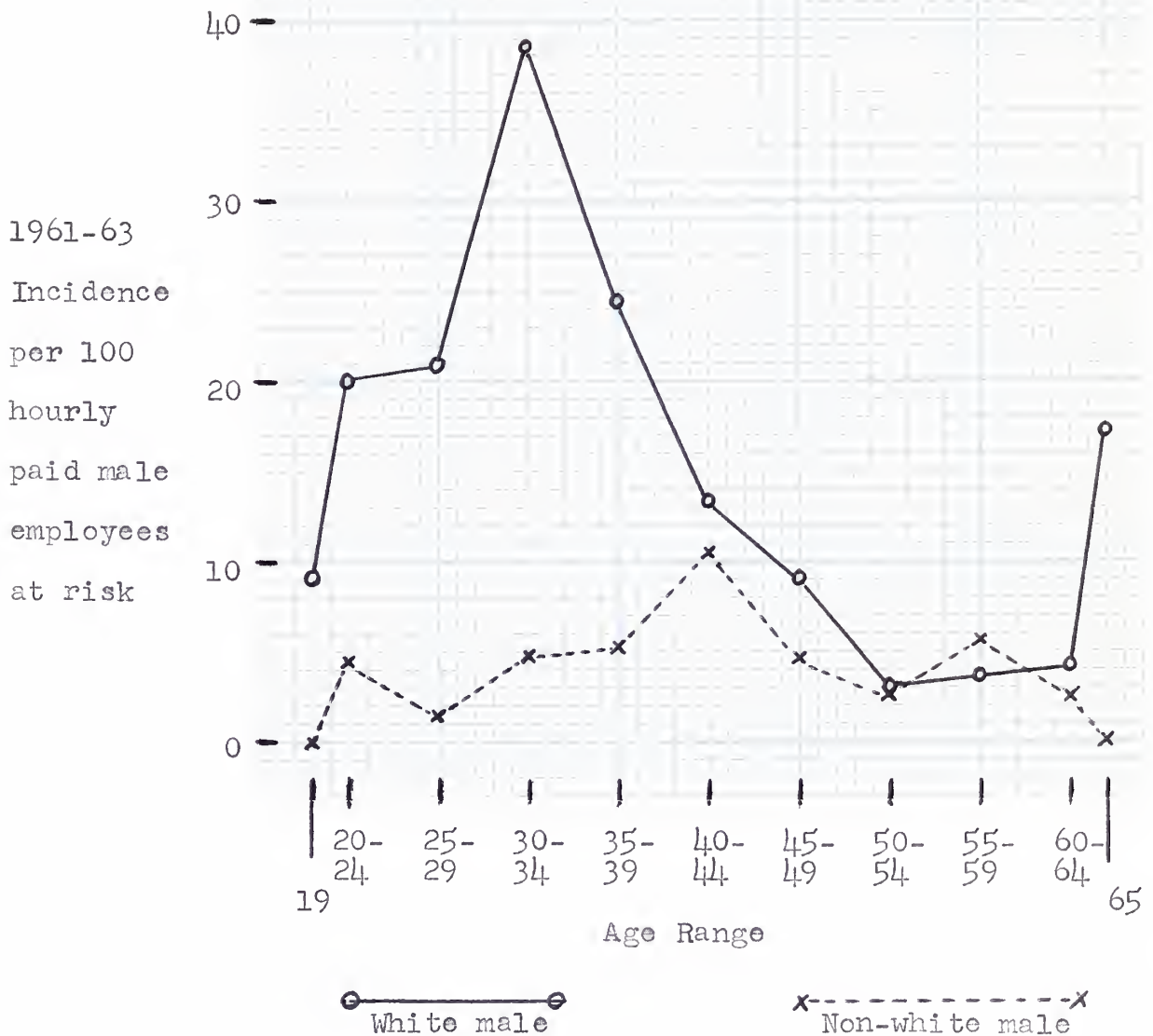


Figure 1: Incidence of back pain by age group during 1961-63, per 100 employees at risk, for white and non-white male hourly paid employees.

and the numbers aged 40 years or more, are noted in Table 8, summarized from Tables 2 and 3.

Age	White male hourly paid employees		Non-white male hourly paid employees	
	Population* at risk	Back Pain group	Population at risk	Back Pain group
<40 years	463	105	667	23
≥40 years	1173	78	330	20
Totals	1636	183	997	43

* Estimated as explained in Section E., p. 45.

Table 8: Numbers of hourly paid male employees among the population at risk and the back pain group by race and by age grouping less than 40 years or 40 years and more.

In the same manner as above, the incidence of back pain among these employees per 100 employees at risk has been calculated. The incidences are presented in Table 9.

Age	White male hourly paid employees	Non-white male hourly paid employees
<40 years	22.7	3.5
≥40 years	6.7	6.1
All ages	11.2	4.3

Table 9: Incidence of back pain by two age groups during 1961-63, per 100 employees at risk, for white and non-white male hourly paid employees.

It is concluded from the foregoing data that complaints of back pain are presented by employees of all ages represented

among the plant's employees, but the distribution by age of the employees who have presented back pain complaints is not random. The incidence of back pain is more than three times as great among white male hourly paid employees aged less than 40 as it is among those aged 40 years or more. Among Negro male hourly paid employees there is a higher incidence of back pain among the employees aged 40 years or more. At all ages, the incidence of back pain among male hourly paid employees is higher among whites than non-whites.

Marital Status (Hourly paid white male complainants):

Marital status is grouped here as single, married, or other. Table 10 indicates the numbers of white male hourly paid complainants and their matched controls in each of these categories. The observed differences are small and insignificant.

Marital Status	Matched Controls		White male hourly paid complainants	
	#	%	#	%
Single	18	18	35	17
Married	80	80	170	82
Other	2	2	2	1
Totals	100	100	207	100

Table 10: Distribution of the hourly paid white male back pain complainants and their matched controls according to marital status.

Table 11 demonstrates that there has been no distortion of the figures in Table 10 by the use of complainants rather than employees. The percentages in the three marital status categories

are the same whether complainants or employees are characterized.

Marital Status	White male hourly paid employees	
	#	%
Single	32	17
Married	149	82
Other	2	1
Totals	183	100

Table 11: Distribution of the hourly paid white male employees with back pain according to marital status.

It is concluded that marital status is of no significance in characterizing hourly paid white male back pain complainants among the hourly paid white male population at risk.

Social Class (Hourly paid white male complainants):

Table 12 indicates the calculated social class designations of the white male hourly paid back pain complainants and their matched controls.

Social Class	Matched Controls		White male hourly paid complainants	
	#	%	#	%
4	42	46	90	47
5	50	54	103	53
Totals	92	100	193	100
Unknown	8	-	14	-

Table 12: Distribution of the white male hourly paid back pain complainants and their matched controls according to social class.

Table 13 demonstrates that there has been no distortion of the figures in Table 12 by the use of complainants rather than employees. The percentages in the two social classes which are represented are the same whether complainants or employees are characterized.

Social Class	White male hourly paid employees	
	#	%
4	79	47
5	90	53
Totals	169	100
Unknown	14	-

Table 13: Distribution of the white male hourly paid employees with back pain according to social class.

It is concluded that social class is of no significance in characterizing white male hourly paid back pain complainants among the hourly paid white male population at risk.

2. Occupational Factors (hourly paid white male complainants)

Time at Olin:

Table 14 indicates the numbers of hourly paid white male back pain complainants and their matched controls who had been employed at Olin for greater than or equal to and less than 24 months.

The difference between the percentages who were employed for more than 24 months is significant (observed difference is

Time at Olin	Matched Controls		White male hourly paid complainants	
	#	%	#	%
>24 months	79	81	134	67
≤24 months	19	19	67	33
Totals	98	100	201	100
Unknown	2	-	6	-

Table 14: Distribution of the white male hourly paid back pain complainants and their matched controls according to length of time employed at Olin.

2.7 times its standard error,. It is concluded that a significantly larger percentage of white male hourly paid complainants were employed by the company for 24 months or less at the time of the back pain episode, when compared to the percentage of their matched controls who were employed for 24 months or less at the time of the base date.

However, it has been noted above that there is a considerably higher incidence of back pain among younger employees. That younger complainants compose a larger proportion of the complainants represented in the group employed for 24 months or less is evident from Table 15.

The difference between the percentages of all back complainants aged less than 40 years and aged 40 years or more who were employed at Olin for more than 24 months is statistically significant to a high degree of certainty (observed difference is 5.5 times its standard error).

That the significantly larger percentage of relatively

Time at Olin	All Back Pain Complainants			
	Age < 40 years		Age ≥ 40 years	
	#	%	#	%
> 24 months	84	54	100	83
≤ 24 months	72	46	20	17
Totals	156	100	120	100
Unknown	8	-	3	-

Table 15: Distribution of all back pain complainants (total 287) according to age and length of time employed at Olin.

recently employed complainants among the group of hourly paid white male complainants is not simply dependent upon age may be demonstrated.

The white male hourly paid complainants were matched with their controls by age. Therefore, if relatively short duration of employment were dependent upon age alone, it would be expected that similar patterns of duration of employment would be found among these two groups. That this is not the case is demonstrated by the data in Table 16.

The difference between the percentages with duration of employment greater than 24 months and age less than 40 years is probably statistically significant (observed difference is 2.4 times its standard error). A similar but non-significant trend is observed among men aged 40 years or over, where there was a larger proportion of complainants than expected with employment of 24 months or less. It appears that the larger percentage of white male hourly paid complainants who were relatively recently

Time at Olin	Matched Controls				White male hourly paid complainants			
	<40 years		≥40 years		<40 years		≥40 years	
	#	%	#	%	#	%	#	%
>24 months	40	73	39	91	64	55	70	82
≤24 months	15	27	4	9	52	45	15	18
Totals	55	100	43	100	116	100	85	100
Unknown	1	-	1	-	4	-	2	-

Table 16: Distribution of white male hourly paid complainants and their matched controls according to age group and duration of employment at Olin.

employed by the company is not dependent upon age, and that the difference is particularly marked in that group of complainants who are less than 40 years of age.

Time in Specific Job:

The data indicating how long the white male hourly paid complainants and their matched controls had been performing a particular job at the time of the back pain episode or the base date are presented in Table 17.

Time at Job	Matched Controls		White male hourly paid Complainants	
	#	%	#	%
≤6 months	28	29	41	20
>6 months	70	71	161	80
Totals	98	100	202	100
Unknown	2	-	5	-

Table 17: Distribution of the white male hourly paid complainants and their matched controls according to the duration of employment in a specific job at the time of the back pain episode or the base date.



The nine percent difference in the percentages who were employed in a specific job for only six months or less is not statistically significant. Therefore, it is concluded that recent change of job in this plant, as opposed to relatively recent assumption of employment in this plant, is not in itself of significance in characterizing white male hourly paid back pain complainants among the hourly paid white male population at risk.

Labor Grade:

The numbers of white male hourly paid complainants and their matched controls who were in labor grades 1-6 and labor grades 7-12 are noted in Table 18.

Labor Grade	Matched Controls		White male hourly paid complainants	
	#	%	#	%
1-6 (more skilled)	53	56	54	44
7-12 (less skilled)	41	44	68	56
Totals	94	100	122	100
Unknown or not applicable	6	-	85	-

Table 18: Distribution of white male hourly paid complainants and their matched controls according to labor grade.

There is not a significant difference between the percentages of white male hourly paid complainants and their matched controls who were in labor grades 1-6. (Observed difference is .



1.8 times its standard error).

It is concluded that labor grade (and therefore job skill and salary scale) does not in itself significantly characterize white male hourly paid back pain complainants among the hourly paid white male population at risk.

Job Description:

The numbers of white male hourly paid complainants and their matched controls performing jobs of various descriptions are listed in Table 19.

Job Description	Matched Controls		White male hourly paid complainants	
	#	%	#	%
Sedentary	0	0	0	0
Minimal exertion	23	24	19	15
Moderate exertion	51	54	76	61
Heavy work	21	22	29	23
Totals	95	100	124	99
Unknown	5	-	83	-

Table 19: Distribution of white male hourly paid complainants and their matched controls according to job description.

None of the observed differences is statistically significant. Therefore, it is concluded that job description is not in itself of significance in characterizing white male hourly paid back pain complainants among the hourly paid white male population at risk.

Department:

It was believed that if significantly larger proportions of employees in some departments were found to have had back pain, these data would be of interest in suggesting additional occupational-environmental factors which might be implicated in the genesis of back pain. However, for several reasons these data, it was believed, could not be critically evaluated with confidence. There are many departmental units in the plant. Moreover, all of these units are not constant over the period of this study. There was major departmental reorganization during the period of study. Some departments came into, and went out of, existence during the period of the study. Supervisory personnel were sometimes changed. For these and other reasons, it became evident that too many variables, which were not to be easily determined and controlled, were inherent in the identification of groups of employees with the various departments. And even had these variables been non-existent, the numbers of employees in the various departments were too small to be amenable to statistical evaluation. Seventy departments were represented by the employees studied. The numbers of back pain employees in these departments ranged from 1 to 13.

No data will be presented regarding the departmental distribution of the employees with back pain.

Incentive pay:

The numbers of white male hourly paid complainants and their matched controls who were paid on an incentive basis are listed in Table 20.

Incentive Pay*	Matched Controls		White male hourly paid complainants	
	#	%	#	%
Yes	26	31	30	14.5
No	59	69	177	85.5
Totals	85	100	207	100
Unknown	15	-	0	-

*This information was included in accident reports. Inasmuch as all back complainants had at least the accident report from the back pain episode, these data were available for all back pain complainants. Not all matched control employees had an accident report in their file; therefore, because of deficiencies of information from other sources, these data could not be determined for 15 of the matched control employees.

Table 20: Distribution of white male hourly paid complainants and their matched controls according to numbers who were or were not paid on an incentive basis.

There is a significant difference between the percentages of the white male hourly paid complainants and their matched controls who were paid on an incentive basis (observed difference is 3.0 times its standard error). It is concluded that there is a significantly lower percentage of white male hourly paid back pain complainants who are paid on an incentive basis than there are employees paid on this basis among the hourly paid white males at risk.

Overtime:

The number of hours of overtime worked by each back pain employee during the three days prior to the presentation of his back complaint to the Medical Department was recorded. However,

control data which could be critically compared with these data could not be obtained. Moreover, the number of employees with back pain who had worked overtime during the three days prior to the presentation of their complaint was relatively small. Only 25 complaints of back pain were preceded by overtime work, ranging from 1 to 8 hours, during the three days prior to the complaint. For these reasons, analysis of the possible temporal association of overtime work with the presentation of a back complaint was not attempted.

3. Medical-physical Factors (Hourly paid white male employees or complainants)

Weight Status:

The weight status of the white male hourly paid employees and the white male hourly paid matched control employees is recorded in Table 21.

Weight Status	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
Underweight	1	1	5	4
Within Normal limits	30	53	58	45
Overweight <15 lbs.	8	14	27	21
Overweight ≥15 lbs.	18	32	38	30
Totals	57	100	128	100
Unknown	43	-	55	-

Table 21: Weight status of white male hourly paid employees with back pain and of white male hourly paid matched control employees.

Although there are some fairly large differences between the percentages of the matched controls and the white male hourly paid employees with back pain which fell into the various weight status categories, none of the differences is statistically significant.

Whereas larger quantities of data might make it possible to characterize on the basis of weight status employees with back pain among a population at risk, no statistically significant characterization can be made with the data presented here.

History of Significant Illness:

For the reasons discussed above, no data except the following will be presented.

Hernia:

The frequency with which a history of hernia was observed in the records of the white male hourly paid employees and the matched controls is recorded in Table 22.

History of Hernia	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
Present	12	12	25	14
Absent	88	88	151	86
Totals	100	100	176	100
Unknown	0	-	7	-

Table 22: Distribution of white male hourly paid employees with back pain and matched control employees according to the presence or absence of a recorded history of hernia.

The difference between the percentage who had a history of hernia of the white male hourly paid employees with back pain and the matched control employees is small and insignificant. It is concluded that the history of hernia does not significantly characterize white male hourly paid employees with back pain among a white male hourly paid population at risk.

Appendectomy:

The frequency with which a history of appendectomy was observed in the records of the white male hourly paid employees with back pain and in the records of the matched controls is recorded in Table 23.

Appendectomy	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
Present	8	8	43	24
Absent	92	92	133	76
Totals	100	100	176	100
Unknown	0	-	7	-

Table 23: Distribution of white male hourly paid employees with back pain and matched control employees according to the presence or absence of a recorded history of appendectomy.

A considerably higher percentage of white male hourly paid employees with back pain had a recorded history of appendectomy than did the matched control employees (observed difference is 3.8 times its standard error). It is concluded that the presence of a recorded history of appendectomy significantly characterizes

white male hourly paid employees with back pain among a white male hourly paid population at risk.

History of Back Pain:

The presence or the absence of a history of back pain, prior to the present study, among the white male hourly paid employees with back pain and among the matched controls is recorded in Table 24.

History of Back Pain Prior to This Study	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
None	59	59	76	43
Positive; not examined at Olin	4	4	22	12
Positive; examined at Olin	37	37	79	45
Totals	100	100	177	100
Unknown	0	-	6	-

Table 24: Distribution of the white male hourly paid employees with back pain during 1961-63 and the matched control employees according to the presence or absence of a history of back pain prior to the first back pain episode during 1961-63 or prior to the base date.

Inasmuch as the second category, a positive history of back pain for which the employee had not been examined at the Medical Department, is probably inflated in the back pain group by history which was not previously recorded in the employees' medical charts, but was obtained at the time of examination for the complaint under study, valid comparisons can be made only



between the last category and the sum of the first two categories in Table 24. The table shows that a slightly higher than expected proportion of white male hourly paid employees with back pain during 1961-63 had a history of back pain prior to the present study. The difference between employees with back pain during 1961-63 and the matched controls was not significant.

Disk Disease:

The percentages of the white male hourly paid employees with back pain during 1961-63 and the white male hourly paid matched controls who had a history of disk disease are recorded in Table 25.

Disk Disease	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
None (not documented)	85	93	138	94
None (documented)	8		26	
Present	7	7	10	6
Totals	100	100	174	100
Unknown	0	-	9	-

Table 25: Distribution of white male hourly paid employees with back pain during 1961-63 and the matched control employees according to history of disk disease.

The percentages of employees among whom disk disease was recorded as being present were essentially the same among the white male hourly paid employees with back pain and among the matched controls. Although disk disease is of necessity very

ill-defined as it is used in this study, it is assumed that there has been relative consistency in the application of the term to various groups of employees. Therefore, with some reservations, it is concluded that the presence or absence of evidence suggesting disk disease did not significantly characterize white male hourly paid employees with back pain among a white male hourly paid population at risk.

Spine Surgery:

Three of the one hundred white male hourly paid employees composing the matched control group had had surgery on their spine. Three of the white male hourly paid employees in the back pain group had spinal surgery subsequent to the complaint for which they were included in this study. One white male hourly paid employee in this study had had spinal surgery prior to the back complaint for which he was included in this study. This individual also had another operation on his spine later. There was no statistical difference between the two groups.

Absence:

Because of the questionable accuracy with which absences were designated as "medical" by the personnel records, it was decided that calculation and comparison of mean absences would be reliable only for the means of total absences. Therefore, in Table 26, only total absences are noted, and no effort is made to differentiate "medical" and "other" absences. These data have been derived from the accumulated data of all employees in these two groups who were at risk during the entire one year

prior to the back pain episode or prior to the base date for the controls.

Absence Data	Matched Control	White male hourly paid complainants
Number at risk for 1 year prior to index date	74	150
Mean Absence (days)	9.8	5.8
Standard deviation	20.9	8.2
Range (days)	0-155	0-56
Median	4	3-4
Mode	0	0
Number not at risk prior year	26	57

Table 26: Absence data for the white male hourly paid back pain complainants and their matched controls for the one year prior to the back pain episode or base date.

White male hourly paid complainants had shorter mean total absence than their matched controls but the difference was not statistically significant. They had a significantly smaller variance than did the matched controls.

Unrelated Occupational Accidents:

The hypothesis was entertained that employees with back pain might have higher rates of unrelated occupational accidents than would their controls. In an attempt to test this hypothesis, data regarding the occurrence of unrelated accidents were collected, in the manner described above, for both the matched controls and for all of the back pain complainants. In the discussion which follows, however, data are presented only for



employees, and not for complainants. That is, each employee is represented only once. For those employees who had been represented more than once in the back pain study, only data from around the first back pain episode are included in the figures which are presented.

It was found that the overall incidence of unrelated occupational accidents, both before and after the back complaint, was higher among the white males with back pain than it was, either before or after the base date, among their controls.

24 months BEFORE the back complaint or base date	Matched Controls	White male hourly paid employees with back pain
Total man months of risk	2099	3583
Total unrelated occupational accidents	198	577
Accidents/man/month	0.094	0.161
Employees for whom data were known	98	182
Employees for whom data were unknown	2	1

Table 27: Man months of risk, unrelated occupational accidents, and accidents/man/month during the 24 months before the back complaint or base date for the white male hourly paid employees with back pain and the white male hourly paid matched controls.

Tables 27 and 28 present the data which illustrate the patterns which were observed in the occurrence of occupational accidents among the white male hourly paid employees with back pain and the matched control employees.



24 months AFTER the back complaint or base date	Matched Controls	White male hourly paid employees with back pain
Total man months of risk	2095	2992
Total unrelated occupational accidents	180	401
Accidents/man/month	0.086	0.134
Employees for whom data were known	100	177
Employees for whom data were unknown or not appropriate	0	6

Table 28: Man months of risk, unrelated occupational accidents, and accidents/man/month during the 24 months after the back complaint or base date for the white male hourly paid employees with back pain and the white male hourly paid matched controls.

Because of the manner in which the data were being studied, it was easier to compare proportions of employees for whom the accident rate was in specified ranges than it was to compare mean accident rates. Therefore, the numbers of employees were separately determined, for both before and after the back complaint or base date, for whom the accident rate was 0.12 accidents/man/month or less and for whom the accident rate was greater than 0.12 accidents/man/month. These data are presented in Tables 29 and 30 on the following page.

It is statistically significant that more white males with back pain than their matched controls had accident rates greater than 0.12 accidents/man/month. This is true for the percentage both before and after the base date or back pain episode. The observed difference for the time before the back pain episode or

Accident rate BEFORE	Matched Controls		White male hourly paid employees with back pain	
	#	%	#	%
≤0.12 accidents/man/month	72	73	91	50
>0.12 accidents/man/month	26	27	91	50
Totals	98	100	182	100
Unknown	2	-	1	-

Table 29: Distribution of white male hourly paid employees with back pain and white male hourly paid matched controls according to the incidence of unrelated occupational accidents during the 24 months before the back pain episode or base date. The data for an employee at risk for less than 24 months were computed on the basis of the number of months during which he was at risk.

Accident rate AFTER	Matched Controls		White male hourly paid employees with back pain.	
	#	%	#	%
≤0.12 accidents/man/month	72	72	100	56
>0.12 accidents/man/month	28	28	77	44
Totals	98	100	177	100
Unknown or not appropriate	2	-	6	-

Table 30: Distribution of white male hourly paid employees with back pain and white male hourly paid matched controls according to the incidence of unrelated occupational accidents during the 24 months after the back pain episode or base date. The data for an employee at risk for less than 24 months were computed on the basis of the number of months during which he was at risk.

base date is 4.0 times its standard error. The observed difference for the time after the back pain episode or base date is 2.7 times its standard error.

It is concluded, therefore, that the white male employees who had back pain during the three years of this study had significantly higher rates of unrelated occupational accidents, both before and after their episode of back pain, than did their matched controls during comparable periods of time.

4. General, Occupational, and Medical-physical Factors: characteristics of Negro male hourly paid employees or complainants

It has been noted that only white male hourly paid complainants were matched with a control group. Negro male hourly paid complainants were not matched with a control group. Therefore, data for a number of factors about the Negro male hourly paid complainants have not been presented above. Because these data are available, they will be briefly presented to characterize the Negro male hourly paid complainants in relation to the white male hourly paid complainants, even though the significance of the characterization cannot be estimated because of the lack of control data.

The Negro male hourly paid employees were essentially ~~the~~ ^{to the} comparable whites in regard to the following factors: marital status, length of employment by Olin, numbers paid on an incentive basis, weight status, and the numbers who had a history of back pain or of disk disease.

The following differences are noted.

Of the 51 of 52 Negro male hourly paid complainants for whom data were available, 27 percent were of social class 4 and 73 percent were of social class 5. There was a significant difference between the percentages of negroes and whites (see Table 10) in these two social classes, with many more negroes in the lower social class (observed difference is 3.0 times its standard error).

Forty-four percent of the 52 Negro male complainants had been performing the same job for six months or less, considerably more than the percentage of white males (see Table 15). The observed difference is 3.2 times its standard error.

Only 13 percent of the 46 of 52 Negro male hourly paid complainants for whom the data were available were in labor grades 1-6. This is very considerably smaller than the percentage of white males (see Table 18) who were in these labor grades (observed difference is 4.6 times its standard error).

Of the 46 of 52 complainants for whom the data were available, 43 percent of the negro males were performing jobs which were characterized as heavy. This is a significantly larger percentage than that of comparable white males (see Table 19). The observed difference is 2.4 times its standard error.

For the 30 of 52 negro male hourly paid complainants for whom appropriate data were available the mean absence during the one year prior to the back pain episode was 12.4 days, with a standard deviation of 19.9 days. The range was 0-88 days; the median was 6 days; the mode was 7 days. These data differ rather markedly from those of the comparable white males (see Table 26),

suggesting greater absence among the negro male complainants. However, because of the wide range of absent days, the apparently wide difference between their mean absences is not statistically significant (observed difference is 1.8 times its standard error).

The 43 Negro male hourly paid employees had, during the 24 months before their back pain episodes, a collective rate of unrelated occupational accidents of 0.222 accidents/man/month. Sixty-three percent of these employees had a rate equal to or greater than 0.12 accidents/man/month. During the 24 months after the back pain episodes, they had a collective rate of 0.147 accidents/man/month, with only 32 percent having a rate equal to or in excess of 0.12 accidents/man/month. Although all data suggest that, in relation to the white male hourly paid employees (see Tables 27-30), they had higher rates of unrelated accidents, the differences are not statistically significant.

B. Factors Describing the Back Pain Episode

1. Time factors

Month (all hourly paid complainants):

There is a pronounced and well recognized annual cyclical pattern observed in the frequency of all industrial accidents. In order to test the hypothesis that there is a similar cyclical pattern to the incidence of backache it was necessary to collect data with which a monthly frequency rate could be calculated for backache. The sum of the numbers of hourly paid employees at risk each month during the three years of this study was determined as accurately as possible for each month. Because of some organizational changes which were made in the plant, it was necessary to extrapolate small known numbers from the first 18 months of the study. The numbers so extrapolated were relatively small and it is assumed that any errors which were introduced were insignificant. Table 31 indicates the total numbers of all hourly paid employees at risk each month during the three years of the study (the sum of the number at risk during the given month in 1961, plus 1962, plus 1963). The table further indicates the total number of all backaches which were reported during these months by hourly paid employees, and the calculated numbers of backaches per 1000 hourly paid employees at risk per month which occurred during the given months. The numbers of hourly paid employees at risk each month have been corrected for the

Month	Number of all hourly paid employees at risk - three years (corrected for days at risk each month)	Number of backaches reported by hourly paid employees - three years	Number of backaches per 1000 hourly paid employees at risk per month
January	9,699	27	2.79
February	9,537	31	3.25
March	9,330	22	2.36
April	9,219	21	2.28
May	8,847	23	2.60
June	6,441	15	2.33
July	6,138	12	1.96
August	9,240	24	2.60
September	10,029	21	2.09
October	10,473	33	3.16
November	10,347	27	2.61
December	10,002	13	1.30
Totals all months	109,302	269	2.46

Table 31: Number of all hourly paid employees at risk during each calendar month; number of backaches reported by all hourly paid employees during each calendar month; and the number of backaches per 1000 hourly paid employees at risk per month for each calendar month. All figures are the totals for the three years of this study, 1961-63.

numbers of days of risk during those months. This was necessary because the plant was on strike for a month and a half during the summer of 1962, and there were plant vacations for two weeks during the summers of 1961 and 1963. The introduction of these corrections has undoubtedly introduced error into the estimations of the hourly employees at risk each month, although it is assumed that these errors are relatively small.

There is not a well defined pattern to the monthly frequencies with which backaches are reported by all hourly paid employees. The chi-square test was applied to the monthly distribution of backaches. This test indicated that the observed monthly distribution of backaches might frequently have occurred by chance ($p < .20$ and $> .10$). It is concluded, therefore, that a significant monthly cyclical pattern to the incidence of back pain among the hourly paid employees studied cannot be demonstrated. It is observed that the number of backaches per 1000 hourly paid employees at risk per month ranged from a low of 1.96 in July to a high of 3.25 in February, and that the overall incidence of back pain complaints during the three years of the study was 2.46 backaches per 1000 hourly paid employees at risk per month.

Day of the Work Week (all complainants):

The day of the work week on which the complainant's back pain began was recorded for all complainants in the study. The day ranged from the first to the sixth, with the distribution noted in Table 32. Control data are not available to indicate the numbers of employee days of risk which occurred on the

Day of the Work Week	Number of Complaints
1	66
2	51
3	51
4	57
5	46
6	9
Unknown	7
Total	287

Table 32: Distribution of all back pain complaints according to the day of the work week on which the back pain began.

various days of the work week. For the purpose of evaluating the observed distribution of the backache complaints, however, it is assumed that the hours of risk are the same for the first five days of the work week. It is known that only a relatively small proportion of the total days of risk is experienced on the sixth day of the work week. Therefore, a chi-square analysis of the distribution of back pain complaints by the day of the work week was done for the first five days of the work week. The chi-square of this distribution indicated a large probability that it might have occurred by chance ($p < .30$ and $> .20$).

It is concluded, therefore, that there was not a significant difference in the numbers of backaches which began on the first five days of the work week. Control data are lacking with which

to make a conclusion regarding the frequency with which backache began on the sixth day of the work week.

In spite of the fact that the observed distribution of backaches might frequently have arisen by chance, it is interesting to note the order in which the observed frequencies occurred. There were over 40 percent more backaches beginning on the first day of the work week. The chi-square test does not take into consideration the order in which the values occur. One wonders, in spite of the statistical evidence, whether more knowledge of the factors involved in the genesis of backache would give greater significance to the different frequencies which are observed in the occurrence of backache early and late in the work week.

Hours Worked before the Onset of Back Pain (all complainants):

For each complainant, for whom the data were available, it was recorded how many hours had been worked before the back pain began (no matter what the "cause" of the back pain). The number of hours were recorded to the nearest hour. On the presumption that most employees were exposed to eight hours of risk, the percentages of complainants for whom back pain began after various hours of work, up to eight hours, were computed. Those seven complainants for whom back pain began after eight hours of work have been disregarded in the discussion which follows. It must be realized that backaches during only half as much time at risk contributed to the figures for the 0 and 8 hours at work divisions. For example, no employee worked fewer than zero minutes, and if

he had worked 31 minutes his backache was considered to have begun after one hour at work. Correction has been approximated for this fact in the figures which are presented below. This has been done by calculating the percentages of backaches which occurred during half hour periods. This calculation has been made by adding the total number of backaches which occurred during the 1-7 hour divisions, plus two times the number of backaches which occurred during the 0 and the 8 hour divisions. Then the percentages of backaches which occurred during the 1-7 hour periods were calculated by dividing the total number of backaches during the specific periods by the total number of backaches during all periods which was calculated in the manner described. The percentages of backaches which occurred during the 0 and 8 hour divisions were calculated by dividing two times the actual number of backaches which occurred during those periods by the total number of backaches which was calculated in the manner described. These data for the whole back pain group are presented in Table 33.

The "corrected" numbers of backaches which began during each hour after the beginning of the work day were were believed to be a reasonably accurate reflection of the "incidence" of back pain which began during these hours. Chi-square analysis was done upon the corrected numbers of backaches during the nine periods of time. The probability values are $p < .10$ and $> .05$. It could not be concluded with confidence, therefore, that the hourly "incidence" of back pain observed for the whole group of complainants was not distributed in a random fashion.

Number of hours worked before onset of pain	Back Pain Complainants			
	Actual #	Corrected #	Actual %	Corrected %
0	21	42	8	15
1	33	33	13	12
2	41	41	16	14
3	37	37	15	13
4	26	26	10	9
5	23	23	9	8
6	29	29	12	10
7	27	27	11	10
8	13	26	5	9
Working total	250	284	99	100
Pain began after >8 hours at work	7			
Pain did not begin at work	30			
Total	287			

Table 33: Numbers of actual and corrected back pain complaints for which the onset of back pain was recorded as having begun after various hours of work from 0 to 8 hours (to the nearest hour).

However, further analysis was made of the figures for the "incidence" of back pain by the time of day when the pain began.

One of the variables which was recorded for each back complaint was the number of days which had elapsed between the appearance of back pain and the day when it was reported to the Medical Department. Fifty-seven percent of all complaints for which the data were available, or 162 of 287 complaints, had been presented to the Medical Department on the day when pain was first noted. The remaining 43 percent of complaints were not



presented until one or more days following the first appearance of pain. The distribution of back complaints by the number of days between the first recognition of pain and its presentation to the Medical Department is outlined in Table 34.

Days between the onset of back pain and its presentation to the Medical Department	Back Complaints	
	#	%
Same day	162	57
1 day	63	22
2-5 days	50	18
6-9 days	6	2
10 or more days	4	1
Totals	285	100
Unknown	2	-

Table 34: Distribution of all back complaints according to the number of days between the onset of pain and its presentation to the Medical Department.

The hypothesis was entertained that there was a difference between the number of hours worked when back pains began in the group of complainants who had had their pain before the day on which it was reported and those who developed their pain on the day when it was reported. To test this hypothesis the corrected numbers of complainants in these two groups were compared for the number of hours worked before back pain began. Table 35 presents these data.

The corrected numbers of complainants in the various "hours worked" groups were submitted to chi-square analysis. That the

observed distributions might have occurred by chance is highly unlikely ($p < .01$ for both distributions).

Hours Worked	Back pain reported the same day				Back pain present before the day reported			
	Actual		Corrected		Actual		Corrected	
	#	%	#	%	#	%	#	%
0	19	12	38	21	2	2	4	4
1	30	19	30	17	3	3	3	3
2	32	20	32	18	9	10	9	9
3	23	15	23	13	14	15	14	13
4	19	12	19	11	7	8	7	7
5	11	7	11	6	12	13	12	12
6	10	6	10	6	19	20	19	18
7	9	6	9	5	18	19	18	17
8	4	3	8	4	9	10	9	17
Totals	157	100	180	101	93	99	104	100
Data inappropriate or unknown: 37 actual complaints								

Table 35: Numbers of actual and corrected back complaints for which the onset of back pain was recorded as having begun after various hours of work from 0 hours to 8 hours (to the nearest hour), and further differentiated to indicate whether the pain was reported on the same day on which it began or on some day following the day on which it began.

An obvious pattern emerges in both of these groups. Those complainants who reported back pain on the day of its first occurrence experienced their back pain much earlier in their working day than did those who did not report their back pain until some day following its beginning. The group which reported

its back pain on a day following that day on which it began more frequently reported that back pain had begun toward the end of a working period, either three hours after the work day had begun or toward the end of the work day. These patterns are illustrated in Figure 2.

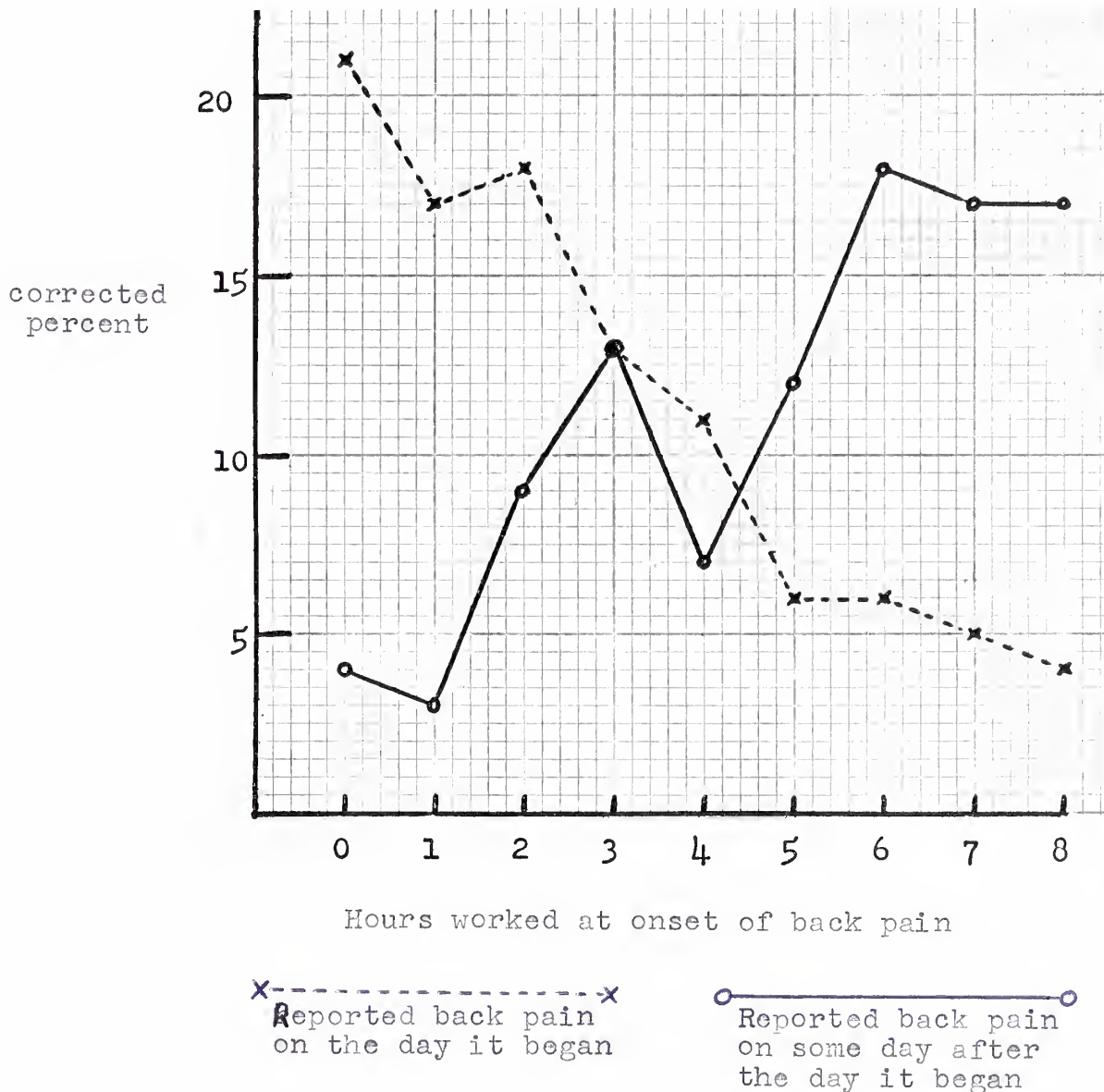


Figure 2: Corrected numbers of back complaints for which the onset of back pain was recorded as having begun after various hours of work from 0 to 8 hours, for two groups: those complainants who reported back pain on the day it began and those complainants who reported back pain on some day after the day it began.

it is concluded that the total numbers of complainants developing back pain after consecutive hours of time worked does not differ significantly from a chance distribution of these complainants over the same time span. However, if the complainants are differentiated by the days between the onset of their symptoms and the presentation of their complaints to medical personnel, then a significantly consistent pattern emerges. Two thirds of those complainants who report their back pain on the day when it first occurs have experienced the onset of their back pain within three and one half hours after beginning work that day. A significantly larger number of those complainants who reported their back pain one or more days after it began had experienced the onset of their back pain during the last three and one half hours of their work day. Possible explanations for these observations have not been documented with the data which are available.

2. Factors associated with the onset of back pain (all complainants)

Associated "Circumstances"

Lifting is frequently in alleged association with back pain. In this series, lifting was associated with the onset of back symptoms in 47 percent of all cases. Further differentiation of the alleged circumstances with which the onset of the back pain was related was limited, in this study, to two categories. These additional circumstances were "other trauma" (frequently bending, twisting, falling, or contact with an object) and "no obvious

trauma." The latter category included such allegedly associated factors as respiratory illness, fatigue, and all of those backaches for which the recorded histories suggested no association with the various forms of trauma. Table 36 presents these data for all white and Negro male complainants.

Associated Circumstances	All Male Complainants			
	White Male		Negro Male	
	#	%	#	%
Lifting	99	45	31	58
Other trauma	86	39	11	21
No obvious trauma	35	16	11	21
Totals	220	100	53	100
Unknown	1	-	0	-

Table 36: Distribution of all male white and negro complainants according to the circumstances allegedly associated with the onset of back pain.

It is not statistically significant that there is a higher frequency of lifting associated with the back pain among the negro complainants. Similarly, the frequency with which no obvious trauma was associated with back pain is not significantly different between negro and white male complainants.

Of the 34 backaches for which there were the physical signs of contusion and/or abrasion noted at the time of examination, two were associated with no known trauma, and one was associated only with lifting.

Of the 253 backaches which were given a diagnosis from the "sprain-strain" category, 164 were low-back sprains and strains,

and 89 were sprains or strains of other regions of the back. The differentiation of associated factors for these two groups reveals no differences of statistical significance. Table 37 presents these data.

Associated Circumstances	Sprain-Strain Backaches			
	Low-back		Other back	
	#	%	#	%
Lifting	91	56	42	47
Other trauma	39	24	30	34
No obvious trauma	33	20	17	19
Totals	163	100	89	100
Unknown	1	-	0	-

Table 37: Distribution of low-back and other back sprain-strain backaches according to the circumstances allegedly associated with the onset of back pain.

Other sub-groups of the back pain group were studied for differences in the frequency with which lifting and other trauma, or no obvious trauma, were associated with their back pains. The data on the entire complainant group and five of the sub-groups are presented in Tables 38-40.

Table 38 shows a larger percentage of complainants who had been in their jobs for six months or less and for whom the back pain was associated with lifting. Lack of information about the remaining complainants precluded statistical tests.

There are no significant differences demonstrable in the alleged circumstances of origin of the back pains of the younger as opposed to the older complainants (Table 39).

A hand-drawn table with 3 columns and 5 rows. The table is drawn with blue ink on a white background. The lines are slightly irregular, suggesting it was drawn by hand. The table is empty, with no text or numbers inside the cells.

Associated Circumstances	All back pain complainants		Complainants in job ≤ 6 months at time of back pain episode	
	#	%	#	%
Lifting	134	47	42	58
Other trauma	100	35	19	26
No obvious trauma	52	18	12	16
Totals	286	100	73	100
Unknown	1	-	1	-

Table 38: Circumstances allegedly associated with the onset of back pain among complainants of the whole back complainant population and among complainants who had been in their job for six months or less at the time of the back pain complaint. The latter is a sub-group of, and is included among, the former.

Associated Circumstances	All back pain complainants			
	Age < 40 years		Age ≥ 40 years	
	#	%	#	%
Lifting	78	49	56	44
Other trauma	51	32	49	39
No obvious trauma	31	19	21	17
Totals	160	100	116	100
Unknown	4	-	7	-

Table 39: Circumstances allegedly associated with the onset of back pain among complainants aged less than 40 years and those aged 40 years or more at the time of the back pain complaint.

Associated Circumstances	All back pain complainants			
	Absence following back pain		No absence following back pain	
	#	%	#	%
Lifting	28	67	96	45
Other trauma	5	12	82	39
No obvious trauma	9	21	34	16
Totals	42	100	212	100
Unknown or not appropriate - 33 complainants				

Table 40: Circumstances allegedly associated with the onset of back pain among complainants who had absence immediately following the presentation of their back pain complaint and among those who were known not to have had absence immediately following the presentation of their back pain complaint.

One factor found to be statistically significant in the alleged association of lifting with the origin of the back pain was the occurrence of subsequent absence with the back pain. Lifting was associated with the origin of the back pain in 22 percent more of the complainants who subsequently lost one or more days of work with their back pain than it was associated with the complainants who lost no work because of their back complaint (see Table 40). The observed difference is 2.7 times its standard error. However, comparison of these two groups of complainants reveals no significant difference in the frequency with which no obvious trauma was associated with the origin of back pain.

To test whether there was more frequently an alleged association of lifting or other trauma with back pain in complainants

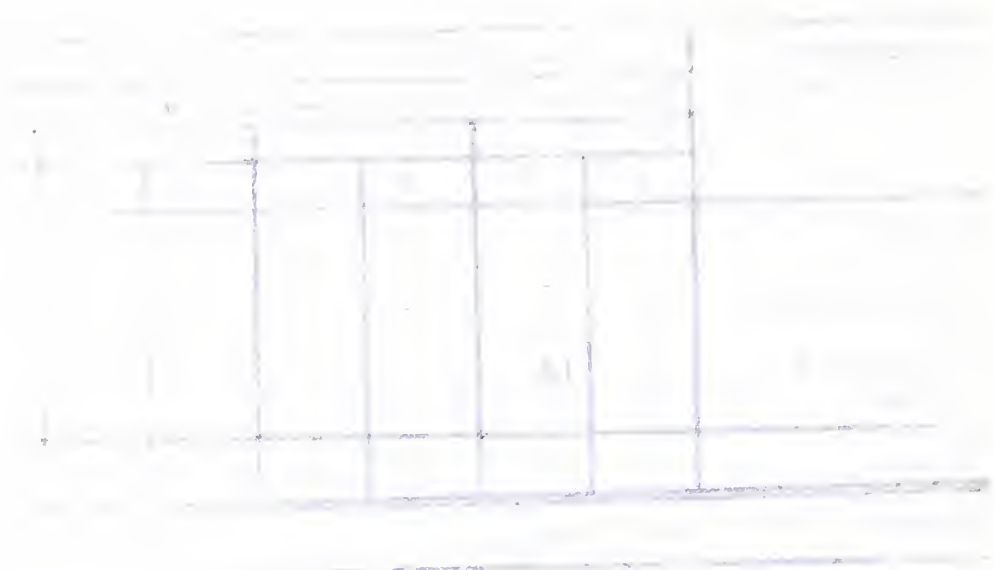
doing heavy work, the frequency with which these factors were so associated was determined for the four job categories which have been previously described (see Methods, p. 38 and Job Description, p. 70). These data are presented in Table 41.

Associated Circumstances	Job Description of Complainants							
	Sedentary				Heavy Physical			
	1		2		3		4	
	#	%	#	%	#	%	#	%
Lifting	0	0	13	39	52	52	27	55
Other trauma	0	0	11	33	35	35	15	31
No obvious trauma	2	100	9	27	13	13	7	14
Totals	2	100	33	99	100	100	49	100
Unknown - 103 complainants								

Table 41: Circumstances allegedly associated with the onset of back pain among complainants in jobs of four graded degrees of physical demand.

Chi-square analysis with groups 1 and 2 combined shows that the observed distribution might frequently occur by chance. It cannot, therefore, on the basis of these data, be stated with confidence that there is a higher frequency of back pain which was associated with lifting or other trauma among those complainants who were engaged in heavy physical work.

It is concluded that lifting was frequently associated with the occurrence of back pain in those back pain complainants who were studied. Other trauma was associated often, but less frequently. Trauma was not recorded as being associated with the occurrence of back pain in approximately 20 percent of the



backaches studied. The frequency with which lifting, other trauma, or no obvious trauma were associated with the onset of back pain did not differ significantly, with two exceptions, in the various sub-groups of the backache population which were subjected to statistical analysis. Those back pains with which contusion and/or abrasion were associated at physical examination were alleged to have been caused by trauma in 32 of 34 cases studied. Those complainants who were absent with their back pain had more often associated lifting with its onset. It is suggested that the frequency with which the three alternative factors were associated with backache did not differ, to a degree unlikely to have arisen by chance, among three groups of complainants classified by differing physical demands of their work. No evidence is submitted to substantiate or to refute a causal association of lifting or other trauma with backache. Nor is evidence submitted to suggest whether or not there was trauma associated with those backaches for which no obvious trauma was observed.

Duration of Symptoms before Reporting Back Pain

Some data have been presented above (p. 92 ff.) regarding the number of days which elapsed between the appearance of back pain and the day on which it was reported to the Medical Department. Various sub-groups of the total back pain group were studied to determine whether there were differences among them in the numbers of complainants who "lived with" their pain before bringing it to the attention of the plant's medical

Days between the onset of back pain and its presentation to the Medical Department	Back Pain Complainants									
	Whole back pain group		Contusion Abrasion		Low-back Sprain-Strain		Disk Disease		Absence following back complaint	
	#	%	#	%	#	%	#	%	#	%
Same day	162	57	23	70	85	52	11	55	18	44
1 day	63	22	6	18	39	24	5	25	9	22
2-5 days	50	18	4	12	34	21	3	15	8	20
6-9 days	6	2	0	0	2	1	1	5	3	7
10 or more days	4	1	0	0	4	2	0	0	3	7
Totals	285	100	33	100	164	100	20	100	41	100
Unknown	2	-	1	-	0	-	1	-	1	-
Not appropriate to category	-	-	253	-	123	-	266	-	245	-

Table 42: Number of days between the onset of back pain and its presentation to the Medical Department, for the whole group of back pain complainants and for four sub-groups of the whole group. The four sub-groups are to be compared with the data of the whole group only; they are not intended to be compared with each other. The contusion-abrasion and the low-back sprain-strain groups are mutually exclusive; otherwise, a single complainant might be represented in three of the four sub-groups for which data are presented in the table.

personnel. The data for some of these sub-groups are presented in Tables 42 and 43.

Days between the onset of back pain and its presentation to the Medical Department	All Male Complainants			
	White males		Negro males	
	#	%	#	%
Same day	127	58	31	58
1 day	48	22	13	25
2-5 days	36	16	8	15
6-9 days	5	2	1	2
10 or more days	3	1	0	0
Totals	219	99	53	100
Unknown	2	-	0	-

Table 43: Number of days between the onset of back pain and its presentation to the Medical Department, for all white and Negro male complainants.

It is noted that there were no major differences among the various sub-groups. In fact, the consistency with which the various sub-groups approximated the distribution observed in the whole study group is surprising. The largest observed differences from the whole group were those noted in the distribution of the complainants who subsequently had absence from work associated with their episode of back pain and in that group of complainants who were given diagnoses of contusion and/or abrasion.

It is concluded that fewer than 60 percent of the back pains which were reported to the Medical Department during the three years of this study were presented to that department on the day

when they began. Over 20 percent were not reported until longer than one day after they began. Some back pains were reported to have been present for more than 10 days before they were presented to the Medical Department. The various sub-groups which were studied ~~did~~ not differ significantly from the whole group in the percentages of their members who reported back pains during progressive intervals after the pain had begun. Data have been presented elsewhere in this paper to illustrate differences which were observed between those complainants who presented their complaint of back pain on the day when the pain began and those who did not present their complaint until later.

3. Factors relating to the evaluation of back pain (all complainants)

Medical Personnel

All employees who report to the medical Department are first seen by a registered nurse. She evaluates the status of the patient and, when indicated, the patient is seen by one of the plant physicians. While it may be true that there are differences among the nurses in the frequency with which, and the reasons for which, they consider evaluation by a physician to be indicated, data in this regard are not available. Moreover, it is unlikely that various kinds of patients were seen with significantly different frequency by nurses of differing orientations. Therefore, the possibility that these factors may have influenced the following data is not taken into consideration.

The percentages of complainants in the whole back pain group, and in several sub-groups, who were seen by a nurse only or by a physician as well are indicated in Table 44.

Seen by	Whole Back Pain Group		Contusion-Abrasion		Low-back Sprain-Strain		Disk Disease	
	#	%	#	%	#	%	#	%
Nurse only	100	35	18	53	40	25	4	19
Physician	186	65	16	47	123	75	17	81
Totals	286	100	34	100	163	100	21	100
Unknown	1	-	0	-	1	-	0	-
Not appropriate to category	-	-	253	-	124	-	266	-

Table 44: The numbers of complainants in the whole study group and in three of its sub-groups who were seen by a nurse only or by a physician as well at the time of the initial visit to the Medical Department with the back complaint. The contusion-abrasion and the low-back sprain-strain sub-groups are mutually exclusive. Complainants in the disk disease sub-group may also appear in one of these sub-groups.

in comparison with the whole back pain group, a smaller percentage of those complainants who were diagnosed as having back pain secondary to a contusion and/or abrasion were seen by a physician. The group which, in relation to the whole group, had the largest percentage of its complainants examined by a physician is that group which included those backaches which were diagnosed as low-back sprain or strain. It is unlikely that chance alone is responsible for the differing percentages of complainants seen by a physician in the low-back sprain-strain



group and in the contusion-abrasion group. Their differing percentages were compared, since the groups were mutually exclusive, and found to be statistically significant (observed difference is 2.6 times its standard error).

That back pain complainants with either previously or subsequently demonstrated disk disease were seen by a physician with greater frequency than were all complainants is not demonstrated with certainty. These disk disease complainants were, however, seen by a physician in a greater percentage of instances than were the complainants who were diagnosed as having back pain secondary to a contusion or abrasion.

In comparison of the following sub-groups with the whole back pain group, the percentages seen by a physician were essentially the same for white males, negro males, those who had been in their specific job for six months or less, those who had a previous history of back pain, and those who were subsequently absent from work for one or more days with their back pain.

It is concluded that almost two-thirds of all complaints of back pain which were presented to the Medical Department during the three years of this study were evaluated by a plant physician. Significantly more of these back complaints which were diagnosed in the broad category of low-back sprain-strain were seen by a physician than were those which were diagnosed as secondary to a contusion or abrasion. Whether this reflects essential differences in the pathology which was present in the complainants of the two groups, or whether the diagnostic classification was secondary to the person by whom it was made, is not determined.

Location of Pain

It has been noted elsewhere in this report that data from complainants with back pain at all levels of the spinal axis have been included in evaluating the factors which have been studied. The location of the back pain, differentiated according to the five areas which have been defined, is recorded for the whole back pain group, and for some of its major sub-groups, in Tables 45-47.

Location of Back Pain	All Male Complainants			
	White Males		Negro Males	
	#	%	#	%
Neck	11	5	6	11
Thoracic spine	49	22	6	11
Lumbar, etc.	144	65	33	62
Other	15	7	3	6
Not well defined	2	1	5	9
Totals	221	100	53	99
Unknown	0	-	0	-

Table 45: Location of back pain in all white and Negro male complainants.

These data illustrate the observation that complaints of back pain at all levels of the spinal axis were made. Moreover, it is evident that there were few significant differences in the anatomical localization of the back pain, within the general areas which have been defined, among the major sub-groups which have been studied. As shown in Table 45, the apparent difference between the frequency with which there were complaints of neck

Location of Back Pain	Complainants					
	Whole Back Pain Group		Disk Disease		Absence following back complaint	
	#	%	#	%	#	%
Neck	19	7	2	10	1	2
Thoracic spine	55	19	3	14	9	21
Lumbar, etc.	188	66	16	76	26	62
Other	18	6	0	0	4	9
Not well defined	5	2	0	0	2	5
Totals	285	100	21	100	42	99
Unknown	2	-	0	-	0	-
Not appropriate to category	0	-	266	-	245	-

Table 46: Location of back pain in complainants of the whole study group and in two of its sub-groups. The two sub-groups are not mutually exclusive, and are to be compared with the data of the whole complainant group.

Location of Back Pain	Complainants			
	Incidence of Unrelated Accidents > 0.12/month		Incidence of Unrelated Accidents ≤ 0.12/month	
	#	%	#	%
Neck	14	10	5	4
Thoracic spine	28	20	23	17
Lumbar, etc.	85	60	96	72
Other	9	6	9	7
Not well defined	6	4	0	0
Totals	142	100	133	100
Unknown - 12 complainants				

Table 47: Location of back pain among complainants who, during the months of risk (up to 24) before the back pain episode, had rates of unrelated accidents of either: greater than; or equal to and less than 0.12 accidents/month.



pain by white and negro male complainants was not significant. However, that there were more complaints by white males of thoracic back pain may be significant (observed difference is 2.2 times its standard error). Table 46 shows similar patterns of location of back pain in complainants of the disk disease sub-group and in the sub-group which was subsequently absent with the back pain. Table 47 shows that back complainants with more than 0.12 accidents/month had a higher proportion of complaints of pain in the neck and thoracic regions than expected. This may be significant (observed difference is 2.1 times its standard error).

Other differences between the whole back pain group and its various sub-groups, which are not presented in the tables, were not of a degree to be statistically significant. The distribution of back pain by the anatomical localization of the pain did not differ significantly from the whole back pain group among complainants who were relatively new in their jobs (six months or less) or among complainants who had a previous history of back pain. Similarly, the back complaints which were diagnosed within the contusion-abrasion diagnostic category did not differ from the whole back pain group in the frequency with which pain was localized to the various anatomical regions, except that there was no neck pain in the contusion-abrasion sub-group.

It is concluded that two-thirds of all back pain among plant employees, for which the plant's medical personnel were consulted, was localized to the low-back region. Almost one-fifth of all back pain was reported to be localized in the

thoracic area. Fifteen percent of the back pain was reported to be in the neck or in other areas of the back which were not well defined. That the anatomical location where back pain was described did not significantly differentiate various sub-groups of the whole back pain population is illustrated. Exceptions to this may be that the white male complainants may have had more thoracic back pain than did Negro male complainants, and complainants who had a higher incidence of unrelated occupational accidents may have had more back pain localized in the neck and thoracic regions than did complainants with a lower incidence of unrelated occupational accidents.

Diagnostic Categories:

The criteria by which complainants were included in this study have been noted elsewhere. The "diagnoses" from the reports of the back complaints studied were differentiated, in the collection of data, only as "contusion-abrasion" or "others appropriate." Whether various sub-groups of the whole back pain population differed in the relative frequency with which one of these "diagnoses" was applied has been studied. Some of the results have been reported earlier in this paper.

In the comparison of the various sub-groups, there is only one significant difference which was observed in the percentages of complainants to whom the two diagnostic categories were applied. More white male than negro male complainants were in the "contusion-abrasion" category (see Table 48). The observed difference between the percentages of white and negro male

"Diagnosis"	Complainants			
	White Males		Negro Males	
	#	%	#	%
"Contusion-abrasion"	31	14	2	4
Other	190	86	51	96
Totals	221	100	53	100

Table 48: Distribution of all male complainants according to the diagnosis which was given to the complainant, among all white and negro male complainants.

complainants who were in the "contusion-abrasion" category is 2.8 times its standard error. It has been noted that there are differences in the jobs performed by these two groups of complainants. Whether factors related to different jobs, and different risks, explain the observed difference in the percentages of the two diagnoses, or whether other factors are responsible, is not determined.

The following sub-groups were essentially the same in the frequencies with which diagnoses from the two categories (sprain-strain vs. contusion-abrasion) were applied to them: those who were relatively new in their jobs; those who had a previous history of back pain; those who were subsequently absent with their back pain; those who were less than 40 years of age; and those who were 40 years of age or more.

It is concluded that 12 percent of all complainants with back pain who were examined during the period of this study were given a diagnosis of contusion and/or abrasion (34 of 287).

The remainder were given another diagnosis, usually "sprain" or "strain." Negro males were less frequently given a diagnosis of contusion and/or abrasion than were white males. Otherwise, no significant differences were found in the frequency with which complainants in various sub-groups were placed in one of these diagnostic categories. Differences between the post-examination experiences of the complainants in the two diagnostic categories will be noted in the section of this paper dealing with the follow-up of the complainants.

Physical Examination:

The only factor from the physical examination for which an attempt was made to collect data was the recorded presence or absence of pain radiation to the buttock(s) or leg(s). It was relatively seldom reported that such radiation of pain was present. In the entire back pain group only 8 percent of complaints were associated with radiation of pain to the buttock(s) and/or the leg(s). As expected, all such pain radiation was found among those complainants with low-back pain.

For only 6 of the 20 complainants with disk disease for whom the data were available was it recorded that there was this radiation of pain. The described pain radiation was observed with greater frequency in the disk disease sub-group, as compared with the whole back pain group (see Table 49). There was not a significantly greater frequency of the described pain radiation, when compared with the whole complainant group, among those complainants who had been examined for back pain at the same medical department before.

Radiation of pain to the buttock(s) and/or the leg(s)	Complainants					
	Whole Back Pain Group		Disk Disease		Prior History of back pain	
	#	%	#	%	#	%
None	255	92	14	70	150	90
Present	21	8	6	30	16	10
Totals	276	100	20	100	166	100
Unknown	11	-	1	-	7	-
Not appropriate to category	0	-	266	-	114	-

Table 49: The presence or absence of pain radiation into the buttock(s) and/or leg(s) among the complainants of the whole study group and two of its sub-groups. The sub-groups are not mutually exclusive, and are to be compared with the data of the whole complainant group.

Radiation of pain to the buttock(s) and/or the leg(s)	Complainants			
	Absence following Back Complaint		No absence following Back Complaint	
	#	%	#	%
None	34	85	191	93
Present	6	15	15	7
Totals	40	100	206	100
Unknown	2	-	7	-

Table 50: The presence or absence of pain radiation into the buttock(s) and/or leg(s) among complainants who were absent following the back pain complaint and among complainants who were not absent. The 32 complainants not represented in the table are those for whom it was not known if absence followed the back complaint.

Radiation of pain to the buttock(s) and/or leg(s)	Complainants			
	Age < 40 years		Age ≥ 40 years	
	#	%	#	%
None	145	93	110	91
Present	10	7	11	9
Totals	155	100	121	100
Unknown	9	-	2	-

Table 51: The presence or absence of pain radiation into the buttock(s) and/or leg(s) among complainants who were less than, and equal to or more than 40 years of age at the time of the back pain episode.

Seven percent of those complainants who were not absent from work because of their back pain had radiation of their pain to the buttock(s) and/or the leg(s). Fifteen percent of those who were absent from work with their back pain had this radiation of their pain (see Table 50). While it seems reasonable to expect that the latter group might include more of those complainants who had experienced the described radiation of pain, the observed difference is not greater than might have occurred by chance.

There was essentially no difference in the frequency with which radiation of pain was associated with back pain of complainants aged less than 40 years and those of 40 years or more (see Table 51).

It is concluded that radiation of pain to the buttock(s) and/or the leg(s) was relatively infrequently observed in association with the complaints of back pain which have been



studied. It was more frequently, though still in a minority of instances, observed in association with the back pains of those complainants who were reported to have documented disk disease. Radiation of pain was not significantly associated with more consequent work absence because of back pain. There was not a significant age difference between those who did and those who did not have this radiation of pain associated with their back pain.

Disk Disease:

The distribution of disk disease in the matched control group and among the white male and Negro male complainants of the back pain group has been defined in a previous section of this paper. That the presence of disk disease was relatively seldom associated in a significant manner with other factors which have been studied has already been illustrated in discussions of these other factors. All of the data will not be collected together in this segment of this paper. Rather, the frequency with which disk disease was demonstrated in the immediate post-complaint period of the 287 back complaints which occurred during the period of this study will be briefly noted.

Of the 21 back complaints which were made by 14 persons who were at some time believed to have disk disease, the condition was "known" to be present prior to 13 of the complaints. Disk disease was "documented" after the back complaint included in this study in 6 instances, or following approximately 2 percent of the back complaints studied. The records of two of the complainants studied indicate that disk disease was documented

following a back complaint subsequent to that for which the complainant was included in this study.

From the data which have been gathered, and because of the small numbers of complainants involved, no significant patterns can be demonstrated to differentiate from the whole back pain group those complainants in whom disk disease was demonstrated to be present immediately following the back complaint which was included in this study.

Referral:

Referral to another physician, either an orthopedic surgeon, a radiologist, or some other private physician, or to some combination of these, was made in the evaluation of 35 of the 287 back complaints which have been studied. There was a total of 7 referrals to an orthopedic surgeon, 16 to a radiologist, and 15 to the patient's private physician. Six referrals were made to various other physicians.

No referral was made in the evaluation of 88 percent of all of the back complaints (252 of 287). There was no significant difference in this rate of referral among the complainants with complaints which were classified in the "contusion-abrasion" and the "sprain-strain" diagnostic categories. Those complainants who were at some time considered to have disk disease were, however, referred to at least one other physician in the evaluation of 38 percent of the complaints which were made (8 of 21). Comparison of the referral percentages of those who were absent with their back pain (33 percent; 14 of 42) with those who were not so absent (6 percent; 13 of 213) reveals that the former

were referred with significantly greater frequency than the latter (observed difference is 3.5 times its standard error).

No attempt will be made to differentiate the frequency with which the various sub-groups of complainants were referred to the specific medical specialists.

It is concluded that most of the back complaints which were made during the period of this study were evaluated completely by the medical personnel of the plant's Medical Department, without the recorded consultation of at least one other physician. Complainants who were either previously or subsequently considered to have disk disease were more frequently evaluated by at least one other physician. No data are presented to suggest whether more disk disease would have been considered to be present in the entire group of complainants if more of them had been referred for special examination. It is further concluded that those complainants who were absent because of their back pain were more frequently referred to at least one other physician than were those complainants who were not so referred. No evidence is presented to suggest whether or not more of those complainants who were not absent with their back pain would have been absent if they had been examined by other physicians.

4. Factors relating to the evaluation of back pain (all complainants)

Follow-up visits to the Medical Department

Some of the complainants were specifically instructed to

return to the Medical Department for subsequent evaluation of their status and/or for (further) treatment. Some few complainants were specifically instructed to consult their private physician for further evaluation and/or treatment. Most complainants, however, were invited, under a variety of instructions, to return to the Medical Department after their first visit if there was apparent reason so to do. Most frequently, follow-up visits to the Medical Department were primarily for further "heat treatment." No attempt has been made to record the reasons for follow-up visits to the Medical Department.

The complainants who presented 51 percent of all back complaints returned to the Medical Department at least once, for some reason, in the follow-up of this back complaint. The data illustrating the numbers of follow-up visits for the whole back pain group, and for the only two sub-groups which differed from it to any significant degree, are presented in Table 52.

A higher proportion of complainants in the disk disease sub-group than in the other groups were seen in follow-up. A smaller proportion of those complainants in the contusion-abrasion diagnostic category than in the other groups were seen in follow-up.

It is concluded that approximately half of the back complaints presented to the Medical Department of this company were not followed by further visits to that department for additional evaluation and/or treatment of that same episode of back pain. Complainants in whom disk disease was considered to be present were seen in follow-up more frequently than were



Number of follow-up visits to the Medical Department	Complainants					
	Whole Back Pain Group		Disk Disease		Contusion-Abrasion	
	#	%	#	%	#	%
None	135	49	5	25	24	75
1	55	20	4	20	4	13
2-5	64	23	5	25	4	13
more than 5	22	8	6	30	0	0
Totals	276	100	20	100	32	101
Unknown	11	-	1	-	2	-

Table 52: The number of follow-up visits to the Medical Department in the evaluation and/or treatment of complainants in the whole back pain group and in two of its sub-groups. The two sub-groups are not mutually exclusive, and are to be compared with the data of the whole complainant group.

other complainants. Those complainants whose back complaints were diagnosed as contusion and/or abrasion were seen in follow-up with significantly lesser frequency than were complainants with other back complaints. No evidence is submitted to suggest whether the frequency of follow-ups in the various sub-groups was dependent upon the application of diagnostic labels which may be more or less accurate, or whether it was dependent upon other factors.

Absence with Back Pain:

The numbers of whole days of work absence, if any, which immediately followed, and were presumably related to, back pain were determined for all of those complainants for whom the data were available. Forty-two back complaints were known to have

been followed by one or more days of absence from work. Work absence was known not to have followed 213 of the 287 back complaints. Therefore, 16 percent of all back complaints, for which data were available, were followed by one or more days of absence from work.

The numbers of days of work lost following the back complaints ranged from one to 170 work days. Mean absence was 15.4 days (standard deviation 37.2 days), but the median absence was two days, and the mode was one day. Table 53 presents the numbers of days lost

Table 53: The numbers of days lost by the 42 complainants who were absent for one or more whole days of work following the presentation of their back complaint.

Number of days lost per absence	Number of complainants losing this number of days
1	17
2	9
3	3
4	3
5	1
8	1
11	1
15	1
25	1
29	1
97	1
106	1
126	1
170	1



When significant, data have been presented elsewhere in this paper to illustrate the manner in which those complainants who were absent with their back pain differed from the whole group of back pain complainants, or from those complainants who did not have absence associated with their back pain.

Surgery:

The data have been presented elsewhere in this paper regarding the frequency with which spinal surgery had been performed upon the employees included in this study. It was noted that one individual had had such surgery both before and after the back complaint for which he was included in this study. Three of the complaints which are included in this study are known to have been followed by spinal surgery. The numbers of back complaints which are followed by spinal surgery were too few to be amenable to significant factor analysis. However, the important conclusion is evident that a small number of the back complaints which have been studied has been followed by consequence of major significance to the individual and to the company.

Recurrence of Back Pain:

With the reservations noted above (Methods, p.44), the recurrence of back pain in various sub-groups of the back pain population can be studied. Tables 54-58 present the recurrences of reported back pain in the whole back pain group and in several of its major sub-groups.

It is observed (Table 54) that approximately one-quarter of all back complaints were followed by at least one recurrence

Recurrence of Back Pain	Complainants							
	Whole Back Pain Group		New in job (≤ 6 mos.)		Previous History of Back Pain		Disk Disease	
	#	%	#	%	#	%	#	%
None	172	73	35	66	101	69	7	47
1 in ≤ 6 months	22	9	6	11	19	13	1	7
1 in > 6 months ≤ 2 yrs.	23	10	5	9	13	9	3	20
> 1 in ≤ 6 months	7	3	3	6	5	3	1	7
> 1 in > 6 mos. ≤ 2 yrs.	13	5	4	8	9	6	3	20
Totals	237	100	53	100	147	100	15	101
Unknown	50	-	20	-	26	-	6	-

Table 54: Recurrence of back pain during several intervals up to two years after the back pain episode among complainants of the whole study group and three of its sub-groups. The sub-groups are not mutually exclusive, and each is to be compared with the whole study group only.

of back pain during the two years which followed the complaint which was included in this study. Approximately one-third of those complainants who had a recurrence had more than one episode of back pain during the two years which followed the episode for which they were placed in this study. Approximately one-third of all recurrences were single during the next two years and occurred during the six months which followed the episode which placed them in this study. A final one-third of all recurrences were single during the next two years and occurred more than six months after the episode which placed them in this study.

In relation to the whole complainant group, the following patterns were found (see Table 54). There was a higher rate of

Table 1				
Year	1990	1991	1992	1993
1990	100	100	100	100
1991	100	100	100	100
1992	100	100	100	100
1993	100	100	100	100
1994	100	100	100	100
1995	100	100	100	100
1996	100	100	100	100
1997	100	100	100	100
1998	100	100	100	100
1999	100	100	100	100
2000	100	100	100	100
2001	100	100	100	100
2002	100	100	100	100
2003	100	100	100	100
2004	100	100	100	100
2005	100	100	100	100
2006	100	100	100	100
2007	100	100	100	100
2008	100	100	100	100
2009	100	100	100	100
2010	100	100	100	100
2011	100	100	100	100
2012	100	100	100	100
2013	100	100	100	100
2014	100	100	100	100
2015	100	100	100	100
2016	100	100	100	100
2017	100	100	100	100
2018	100	100	100	100
2019	100	100	100	100
2020	100	100	100	100
2021	100	100	100	100
2022	100	100	100	100
2023	100	100	100	100
2024	100	100	100	100
2025	100	100	100	100
2026	100	100	100	100
2027	100	100	100	100
2028	100	100	100	100
2029	100	100	100	100
2030	100	100	100	100

Recurrence of back pain	Complainants			
	White Males		Negro Males	
	#	%	#	%
None	136	74	28	64
1 in ≤ 6 months	19	10	3	7
1 in > 6 months ≤ 2 years	13	7	9	20
> 1 in ≤ 6 months	6	3	1	2
> 1 in > 6 months ≤ 2 years	9	5	3	7
Totals	183	99	44	100
Unknown	38	-	9	-

Table 55: Recurrence of back pain among all white and Negro male complainants. (The 13 complainants not represented in this table are the female complainants.)

Recurrence of back pain	Complainants					
	Contusion-Abrasion		Low-back Sprain-Strain		Other-back Sprain-Strain	
	#	%	#	%	#	%
None	19	76	98	72	55	72
1 in ≤ 6 months	1	4	12	9	9	12
1 in > 6 months ≤ 2 years	3	12	14	10	6	8
> 1 in ≤ 6 months	1	4	5	4	1	1
> 1 in > 6 months ≤ 2 years	1	4	7	5	5	7
Totals	25	100	136	100	76	100
Unknown	11	-	28	-	13	-

Table 56: Recurrence of back pain among the various sub-groups by diagnostic category. All complainants are represented in this table. None of the groups includes complainants represented in another group.

Recurrence of back pain	Complainants			
	No absence after back complaint		Absence after back complaint	
	#	%	#	%
None	138	72	20	71
1 in ≤ 6 months	20	10	2	7
1 in > 6 months ≤ 2 years	19	10	2	7
> 1 in ≤ 6 months	4	2	3	11
> 1 in > 6 months ≤ 2 years	11	6	1	4
Totals	192	100	28	100
Unknown	21	-	14	-

Table 57: Recurrence of back pain among those complainants who were absent following the back complaint and among those who were not. The 32 complainants not represented in this table are those for whom it was not known with certainty whether absence followed.

recurrence among those complainants who had been in their specific jobs for six months or less at the time of the back pain episode which placed them in this study. There was a slightly higher rate of recurrence among those complainants who had had a history of back pain prior to the episode of back pain which placed them in this study. There was a higher rate of recurrence among those few complainants who were considered to have disk disease. Although these differences did not permit statistical test because of overlaps in groups, none of them is very large.

More white than Negro male complainants had a recurrence of back pain, but the percentage difference is not greater than could frequently have occurred by chance (see Table 55).

Complainants whose backaches had been placed in the contusion-

Recurrence of back pain	Employees			
	Incidence of Un-related Accidents >0.12 Acc./month		Incidence of Un-related Accidents ≤0.12 Acc./month	
	#	%	#	%
None	70	67	84	81
1 in ≤6 months	10	10	6	6
1 in >6 months ≤2 years	13	12	7	7
>1 in ≤6 months	5	5	1	1
>1 in >6 months ≤2 years	7	7	6	6
Totals	105	101	104	101
Unknown - 42 employees				

Table 58: Recurrence of back pain among employees who had less than or equal to and more than 0.12 accidents/month during the months they were at risk (up to 24) before the back pain episode. Data from the first back pain episode are used for those complainants represented more than once in the study. Either accident or recurrence data were unknown for 42 employees.

abrasion diagnostic category had insignificantly fewer recurrences of back pain than did those complainants whose backaches had been placed in the low-back "strain-sprain" category (see Table 56).

Complainants whose pain had been in the low-back region and whose backaches were placed in the "strain-sprain" category had a rate of recurrence which was almost identical to that of those complainants whose pain had been in other regions of the back and whose backaches were placed in the "strain-sprain" category (see Table 56).

There was essentially the same recurrence rate among those

complainants who were absent with their episode of pain which placed them in this study and among those who were not so absent (see Table 57).

Finally, a significantly higher rate of recurrence of back pain occurred among those employees who had an incidence of unrelated occupational accidents of greater than 0.12 accidents/month during the two years prior to the back pain episode which placed them in this study than there was among those employees who had a lower incidence of unrelated occupational accidents. This observed difference is 2.3 times its standard error. (See Table 58).

IV. Discussion

The data presented here are viewed as being possibly significant only from a perspective considerably wider than that afforded by the original data reported above. No attempt will be made, on the basis of these data, to make summary "conclusions" regarding back pain in its entirety. It is believed that a more valid understanding of the many factors which relate to back pain will be accomplished, in the future, only with the collection, verification, and integration of considerably more data.

A number of very limited "conclusions" have been made on the basis of the original data which have been recorded in this paper. These conclusions have been stated immediately following the findings upon which they are based. This has been done because it is not yet possible to view these limited conclusions from a wide perspective, and thereby to make inclusive conclusions.

The impression which has become increasingly pronounced is that organic-physiological factors, alone, are possibly of considerably less significance in bringing a back complaint to medical attention than are some ill-defined psychological factors. This is not an impression which can be easily made from perusal of the back pain literature. Much of the back pain literature is primarily oriented towards acceptance of the probable (often believed to be certain) organic-physiological nature of the

"causative" factors of back pain. Neither can the impression be verified with the data presented in this paper.

However, some of the patterns which have been illustrated by the original data presented in this paper seem difficult to explain on a primarily organic-physiological basis.

A distinct age and sex incidence of back pain has been described. Do the usually presumed patho-anatomic changes believed to occur coincident with increasing age entirely explain the observed incidence of back pain? Or, might back pain be frequently considered to be analagous to many other "accidents?"

In this series of back pains there is not an annual cyclical pattern observed which is analagous to that of "accidents." But two different groups of employees with back pain have been defined, each of which illustrates rather specific patterns regarding the time of day when back pain symptoms began.

It has been suggested that employees with back pain are, as a group, employees with a considerably higher incidence of "unrelated occupational accidents." The meaning of this association has not been defined, but one wonders whether back pain, like many accidents, may be related to "state of mind."

Whereas back pain seems not to be associated with a higher incidence of hernia in the group of employees studied, it seems to be associated with a history of appendectomy more frequently than would be expected by chance. Does this suggest that back pain tends to occur in persons who are "pain prone?" Or are such organic factors as intra-abdominal adhesions and secondary muscular imbalances more likely explanations?

Independent of age, employees more recently employed by the company are more frequently back pain complainants. Is this secondary to a relative lack of familiarity with the physical demands of the job, and consequently dependent upon organic insults to the back, or are other factors more significant?

Employees paid on an incentive basis have been found to have a considerably lower incidence of back pain than have employees not so paid. Does this suggest that these employees are exposed to lesser risk? Or would a likely possibility be that employees paid on an incentive basis are more willing to live with a back pain than to incur even the small financial loss which a trip to the Medical Department might entail?

It cannot be stated, on the basis of the data reported in this paper, that, for example, intervertebral disk changes are not causally related to back pain in a significant manner. However, it is suggested here that disk disease may play a much less important overall role in back pain, as seen in an industrial medical department, than is suggested by reports of the more severe cases seen by specialists.

It has been illustrated that back pain is frequently alleged to be associated with lifting or other trauma. But are these associations usually causal? Or, are they often made because they have seemed to be logical on the basis of what has become "common sense" to both the lay person and the physician? One may even wonder how frequently even the alleged temporal association is actual, and whether it is sometimes offered by

an employee in the conscious belief that he should suggest evidence to validate his claim to medical attention from the company, instead of from a private physician. Or might a back pain complaint represent either a conscious or unconscious attempt to seek help from a physician for an entirely different problem?

It is undoubtedly a recurrent difficulty of the industrial physician to make a judgment as to when a given patient should be completely evaluated and treated at the expense of the corporation, or when that patient should properly be referred to a private physician, for evaluation and treatment at the expense of the individual. In this study very few backaches were referred away from the company medical department, to a private physician. This would seem to amount to a tacit assumption, on the part of the industrial medical department, of some causal occupational role in the etiology of the backache. In one sense the industrial medical department was compelled to act as though there were a causal occupational role in the etiology of most backaches. This was true because, first, it is so widely assumed as "obvious" that the various work related factors do, indeed, play a major role in the causation of most back pains. And, second, even in cases where it may be understood that occupational factors are not major causative factors in the genesis of the back problem, "aggravation of a pre-existing condition" may often be alleged. Therefore, given the realities of today, it is a practical fact that the industrial medical department must act "as though" most backaches were,

indeed, causally related to occupational factors.

"Occupational factors" are usually understood to connote a relationship of back pain to organic-physiological factors. If the impressions gained from this study are true, that organic-physiological ("occupationally related") factors are not always (perhaps not even often) the only important factors in the genesis of back pain, then the primary concern of the physician with the effects of organic-physiological factors will probably often produce less than optimal resolution of the employee's problem.

The physician who attended most of the men with back pain included in this study had a catholic perspective of the causative factors of back pain. He was always cognizant of the sometimes primary, often secondary, psychological factors attending the complaint of back pain. However, as has been illustrated in the background discussion in an earlier section of this paper, many physicians seem committed to a primarily (or wholly) organic-physiological perspective in their handling of back pain. One hypothesis would be that the latter orientation, alone, would result in less than optimal evaluation and management of the patient with back pain.

A graphic metaphor is that of the "jam pot." To adapt this metaphor to the current discussion, we may visualize the various factors, causative in the genesis of back pain, as layers in the jam pot. Many of the factors may be acting upon, or present in, every individual who is at risk. When a critical accumulation of factors is present, the jam pot will overflow, and back pain

will become evident. The quality and the quantity of these factors may differ to a significant degree from one patient with back pain to another. Perhaps herniation of an intervertebral disk alone may fill the jam pot to overflowing in one instance. In another instance the jam pot may be filled to overflowing by psychological factors alone. In most instances of back pain, there may be a complex configuration of factors, each of which contributes a quantity until the overflowing of the jam pot, resulting in a manifestation of back pain.

Engel's comments (26) seem of great significance to this study. The conclusion of his article on "Psychogenic pain and the pain prone patient" includes the following comments:

"Every physician is free to rediscover for himself what Freud discovered about pain if he follows two simple principles: permit the patients to talk freely and take seriously what the patient says. . . . An interview technique which permits the patient to speak of himself, his family, and his relationships as well as of his symptoms, which does not force a separation between what is regarded as organic and what is regarded as psychological or social, will be tremendously productive in clarifying the patient's illness. . . . Even when (much) interview time . . . is required, this is more economical in time and expense for both the physician and the patient than the currently traditional technique of 'ruling out organic disease' and attempting to establish a diagnosis by exclusion. Such interminable diagnostic procedures may not only be a waste of time and money but may also render virtually impossible the establishment of correct diagnosis simply because the patient himself becomes increasingly oriented towards this type of approach and less spontaneous in revealing personal and psychological data which the physician, by his approach and behavior, has made him feel are completely out of place. . . . The application of the appropriate method is indispensable."

It is believed that recognition of the kinds of data which have been studied in this paper would contribute to some degree

to a perspective of back pain which would, with greater success, utilize the "appropriate method" in its evaluation and treatment.

V. Summary and Conclusions

1. A portion of the back pain literature is reviewed. There is discussion of the frequent occurrence of back pain, of the diagnoses which are often made, and of various factors which are often considered to be important in the causation of back pain. Back pain is frequently attributed to primarily organic-physiological factors. Psychological factors are less often considered in a causal relationship with back pain. There are many impressions, but few well documented data, regarding the epidemiology of back pain. Some of the general accident literature is cited, and the question is posed of possible relationships and similarities between the epidemiology of occupational accidents and back pain.
2. The source of the original data reported here is defined (the Olin Mathieson Chemical Corporation, and its medical, safety, and personnel files). The study group is defined (all back pain complaints reported to this company's medical department during 1961-63). The data which were studied, and the manner in which these data were collected, is defined.
3. It is reported that significantly more male than female hourly paid employees had back pain. At all ages, significantly more white than Negro male hourly paid employees had back pain. Among white male hourly paid employees, there was significantly more back pain among those aged less than 40 years, as opposed to those aged 40 years or more.

4. In comparison of matched controls with white male hourly paid employees who complained of back pain, no significant relationships were found between employees who reported complaints of back pain and the following factors: marital status, social class, the duration of employment in a specific job (as opposed to duration of employment by the company), labor grade (job skill and salary scale), job description (the degree of physical exertion usually required in the performance of the complainant's work), the hours of overtime worked prior to the occurrence of back pain, the total absence from work during the one year prior to back pain, weight status, the history of hernia, the history of previous back pain, the history of disk disease, and the history of spinal surgery.

5. In comparison of matched controls with white male hourly paid employees who complained of back pain, the following factors were found to be of significance in the characterization of those with back pain: back pain was reported more frequently than expected by complainants who were relatively recently employed by the company than by complainants who had been with the company for longer periods of time (independently of age); it was reported less frequently than expected by complainants who were paid on an incentive basis; it was reported more frequently than expected by employees who had a history of appendectomy; it was reported more frequently than expected by employees who had a higher incidence of ^{occupational} unrelated accidents.

6. Negro male hourly paid back pain complainants were not matched with a control group. They differed significantly from the white male hourly paid complainants, in regard to the factors noted in paragraphs 4 and 5 above, only as follows: there were many more Negroes in the lower of the two social classes represented by them; fewer Negroes had been performing the same job for more than six months; more Negroes were in the labor grades indicating lower skill and salary; more Negroes were performing jobs characterized as heavy.
7. It is noted that back pain complaints were made randomly during the calendar year by hourly paid complainants. The frequency with which back pain began on various days of the work week was not significantly different from a chance distribution. Two groups of complainants are defined with significant differences in their patterns of onset of back pain complaints. One group reported to the Medical Department on the day of onset. In this group pain began early in the work day. The second group reported to the Medical Department one or more days after onset of pain. This group claimed onset of pain more commonly in the middle or toward the end of the work period.
8. It is reported that many back pains were associated with lifting or other trauma. Complainants who were subsequently absent with back pain had more frequently associated their

back pain with lifting. The number of days which had elapsed between the onset of the back pains and their presentations to the Medical Department is reported; over 40 percent of back pains were not reported until some day after the day on which they were said to have begun.

9. The manner in which back pain was evaluated by one industrial medical department is reported. The frequency with which the complainants had been examined by a physician (as opposed to by a nurse only) is noted, as are differences between groups of complainants who were so examined. The anatomical distribution of the back pains is discussed, and it is observed that the occurrence of pain in differing locations on the spinal axis did not, with two minor exceptions, differentiate various sub-groups of the back pain population. The reported diagnoses are presented, illustrating that "sprain" or "strain" was the most frequent diagnosis among these complainants, but that various sub-groups of the back pain population did not differ importantly in the diagnoses which were given to their back pain. Limited data are presented from the physical examinations of the back pain complainants. The relative infrequency is noted with which disk disease was associated with the back pains studied. Similarly, the relative infrequency with which complainants were referred to physicians outside of the plant's medical department is noted.

10. Follow-up data are reported for the complainants. It is noted that many complainants were seen in follow-up at the Medical

Department. Relatively few complainants were subsequently absent with their back pain, and only a little over one percent of the reported back pains subsequently led the complainant to surgery. Although most back pains were of relatively little apparent significance, an important few resulted in consequences of major significance to the employee and to the company. The rate of recurrence is estimated, as are the probabilities that more recurrence resulted among those complainants who were believed to have disk disease, and among those employees who had higher rates of unrelated occupational accidents.

11. The results of these studies are discussed and it is suggested that, in some ways, back pain complaints might be profitably considered as similar to other "accidents," particularly insofar as psychological factors may be similarly related to the occurrence of both back pain and other "accidents." It is additionally suggested that the factors important in the genesis of back pain might be more adequately understood from a perspective which acknowledges psychological and various other epidemiologic factors, as well as the usually emphasized organic-physiologic factors alone.

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